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QUARTERLY REPORT FOR PERIOD

JANUARY 10 - APRIL 10, 1976

PROJECT NUMBER NAS 5-22338

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A REGIONAL LAND USE SURVEY
BASED ON REMOTE SENSING
AND OTHER DATA

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Report reflects joint work of Federation, six state participants, and Colorado State University.

16. Abstract
During this quarter a project review meeting was held in Denver. State lead agencies have begun LANDSAT verification procedures based upon standard methods developed by FRMS and CSU. States are also collecting multi-source data for computer compositing at Los Alamos Laboratories. Work continues at CSU on new LANDSAT pattern recognition software (LMS) and the FRMS completed development and documentation of a computer cellular mapping system (CMS-II).

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PREFACE

Objectives: To test and apply Landsat, other remote sensing and ground data, in an optimum mix for seasonal land use survey, for portions of six states in the region (Montana, Wyoming, Colorado, New Mexico, Utah, Arizona). Specifically: (1) to encourage interstate cooperation in the utilization of earth resources satellite technology for solving land use planning problems; (2) to discuss and work toward the development of compatible interagency, interstate information system procedures; (3) to adopt and test a common land use classification; (4) to evaluate the efficiency of a land use information system, utilizing satellite and other data; and (5) to provide a medium for information exchange concerning remote sensing and geo-information systems.

Scope of Work: This quarter's work, January 10 to April 10, is following the work plan of January, 1975. The schedule and time sequence following page 14 of that work plan are used here as references.

Colorado State University has produced greytone maps of the LANDSAT data for each of the four quadrangles in each state. The state lead agencies have that information and are utilizing it for verification of the LANDSAT data. The state lead agencies are also collecting additional ancillary data to be composited with LANDSAT land use/cover information for relevant multi-source land use analyses. A review meeting of the ad hoc committee on Earth Resources Technology Applications and the LANDSAT participants, plus other interested persons from the Rocky Mountain region, was held January 13, 14, 1976 in Denver. Additional information on that session is attached. CSU is now working with the states toward the development of land use classification/cover maps based on LANDSAT information, and Los Alamos Scientific Laboratories are beginning to develop capabilities for multi-source map compositing and analysis.

Conclusions:

A. Standard procedures have been developed for the identification of LANDSAT verification procedures and for collecting information for multi-source map compositing. The state lead agencies are now working on these data collections.
B. Colorado State University and the Federation have completed or nearly completed new software programs for analyzing multi-source and LANDSAT digital information.
C. A project review meeting held in January was well attended and produced significant decisions for follow up on the LANDSAT project.

INTRODUCTION

This is the fourth quarterly report in the 18-month scheduled project.

The project scope is complex and must be described in parallel roles of six state lead agencies, a technical contractor for extracting land use information from LANDSAT digital tapes, Los Alamos Labs preparation for computer mapping and analysis, and the Federation as coordinator and demonstrator of multi-source and multi-purpose information procedures.

This summary refers to activities scheduled for this period in the work schedule and calendar of the original work plan, January, 1975.

Task II.B - Statistically analyze and characterize land use readings in order to recognize erroneous data and determine clear separations between classes--substantially completed; some work continues.

Task II.C - Analyze effects of extraneous variables, i.e., geology soils, etc. on the interpretation of land use classes--substantially completed; some work continues.

Task II.F - Determination of socio-economic and resource topics for combination with LANDSAT data--now being conducted by state lead agencies.

Task II.G - Identify anamolous portions of training sites for correction--completed.

Task II.H - Analyze and correct remote sensing readings for new land use classes--substantially completed; some work continues.

Task III.D - Collect additional data for LANDSAT verification--now underway in all states.

Task III.E - Identify land uses in all cells of selected maps--now underway; (see CSU schedule, Main Text).

Task III.F - Prepare transparent land use classification overlays--now underway; (see CSU schedule, Main Text).

Task III.H - Convene all participants for a review meeting--completed in January; additional meetings scheduled; (see section next reporting interval).

NASA's rapid response to difficulties with U-2 imagery, outlined in the third quarterly report, was helpful even though the project will be unable to utilize some imagery.

On April 1, a project status briefing was held in Denver for Dr. Robert Price of NASA.

The remainder of the report further details activities of this reporting period.

January Project Review Meeting

On January 13, 14, 1976, the Federation's project advisory group, the Ad Hoc Earth Resources Technology Applications Committee, held a meeting in Denver, Colorado, which included project participants and other interested persons from around the Rocky Mountain region. Thirty persons attended that session, which is summarized here. A detailed meeting report is attached in the appendix.

The principal objectives of the meeting were to review progress on the LANDSAT project to date, to discuss any problems or difficulties participants have had in the project, and to outline the upcoming work efforts. Also discussed were a draft outline for a final report to NASA and parallel Federation activities on cellular computer mapping systems (described in the section on new technology).

Future meetings were planned during this session and follow-up activities were outlined for CSU, the Federation, the states and Los Alamos Scientific Laboratories. Most of these follow-up activities are reported in the following sections of the main text.

Some of the key topics discussed included CSU's new pattern recognition software; the statistical analysis of LANDSAT digital information; state verification procedures, work efforts and difficulties of state lead agencies, an exchange of information about other activities in the region; a discussion of follow-on activities, implementation of remote sensing and geo-information systems technology; Los Alamos activities and new composite computer mapping activities at the Federation.

Verification of LANDSAT Data

At the January review meeting, CSU outlined the statistical procedures for identifying land use classes from LANDSAT digital information. Ground truth collection techniques and especially LANDSAT verification techniques were discussed at length, particularly the need for statistical validity in collecting verification information. Verification is the process of comparing samples of what is actually on the ground to the data produced by LANDSAT and previous ground truth comparisons. It was suggested that a ten percent sample be taken--for example, 300 groups of 9 cells, 10 acres each, should be randomly selected as verification sites. As a result of this discussion and later discussions between the lead agencies and CSU, a random scatter was generated for identifying verification sites in each of four quadrangles per state.

Each state has received grey maps of the LANDSAT data for each of the four quadrangles, as well as the random scatter grid for identifying verification sites. This information will be used to facilitate communications with CSU about specific locations on the quadrangles, for state evaluation of the adequacy of registration and for the evaluation of the adequacy and accuracy of locations of homogenous training fields. The instructions for utilizing the random scatter for verification are given below. Two additional forms were developed to aid state lead agencies in this process (see Form V-1 and Form V-2).

Notes on Verification Procedure - Use of Forms V-1 and V-2:

A. Verification Form 1 is simply a final list of your code of land uses, primary and secondary. This is needed to control (1) the further coding of verification sites, (2) to catalog the earlier coding of the training sites, and (3) standardize the CSU coding of the LANDSAT maps for your state. Obviously, your original training sets and their coding are the main constraint on this list--except that you may need to add "OU" for "other classified" land uses which crop up in your verification sites.

B. This verification exercise, in one quad in each state, which is readily accessible, will enable us to improve, and hopefully to economize, further verification procedure. For example, it will give us the basis for estimating the standard deviation of LANDSAT identification of specific land uses, which is essential for statistical evaluation and for the design of most economic sampling. This exercise will also indicate how far we may pursue the secondary or sub-classes of land use, with reasonable statistical confidence.

C. The V-2 form is the verification worksheet, one for each verification plot. Please xerox this form in several hundred copies, as one will be needed for each verification plot.

D. The computer-printed random plot map is being prepared and sent to you by CSU. Each verification plot will contain nine cells of 1.1 acre each, or approximately 10 acres. Each plot may be identified by its row and column, referencing the central cell in each group of nine, according to the row and column numbers printed along the borders at the computer map grid. The V-2 form of each plot should contain this address on the upper right corner.

E. Concerning the small but important spots of land use which are not extensively distributed in the quad, such as Residential, Commercial-Industrial, certain Water classes, and any other critical land uses which appear infrequently, these you may directly plot on your USGS control as verification sites, i.e., without regard to the CSU random plot map. These hand-picked plots may, of course, be larger than the standard 10-acre sampling plots, but nevertheless should be written up on V-2 forms, and each 10-acre portion laid out on your USGS map.

F. Now for all the other, more extensive land uses, it is advisable to trace the verification plots from the computer plot map to a USGS quad map, since the scale is identical, and this may be done on a light table. You may also "address" these plots on the USGS map, lettering the row and column number of the central cell as derived from the computer map.

G. You may proceed immediately to fill in the first three squares of the V-2 form, without waiting for the LANDSAT classification map. Use any reliable combination of aerial photos, field data and field survey. Possibly a zoom transfer scope may expedite this. It is critical that your verification procedure logs the correct location and land use, as this is your sole basis for checking the accuracy of LANDSAT.

H. When the LANDSAT classified land use map arrives, you may complete the fourth box of the V-2 form. This box permits you to log in each 1.1 acre cell. (Caution: do not attempt to use the earlier LANDSAT "greymap" for this purpose, as it is not classified for land use.)

I. It will now be possible to compare the 1st and 4th boxes and begin a tally sheet on the "hits or misses" of the LANDSAT map.

J. When the tally is completed on all your verification cells, you may composite the overall percent accuracy of LANDSAT for each coded class, and log it on the V-1 form.

K. After familiarization with this first quad, we will be able to estimate the standard deviation of the LANDSAT readings on each land use. This will permit economies in further verification of other quadrangles in the state, where you will need to check particularly the different settings <u>where land use patterns, elevations, land form, etc. are substantially different from those in the first quadrangle</u>.

FORM V-1 CODING LIST State _____

List only the land use and cover codes used in your training sets, plus a category OU for "other - unclassified". These codes will constrain the verification procedure, and of course the LANDSAT interpretation.

	Basic Coding		Later Computations			
	Primary Land Use / Cover		% Accuracy of LANDSAT			
		Secondary or sub-classes	Quad 1	Quad 2	Quad 3	Quad 4
Ex:	CI - crops, irrigated		85			
		CI-sb sugar beets	90			
		CI-c corn	80			

FORM V-2 LAND USE VERIFICATION

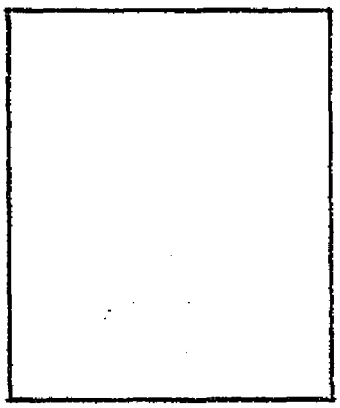
State _____

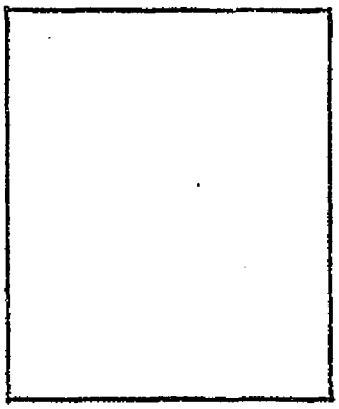
Quad _____

Plot # _____

Land Use / Cover

Divide area as needed and code each portion. Use only codes from V-1 list, plus "other - unclassified" (OU)



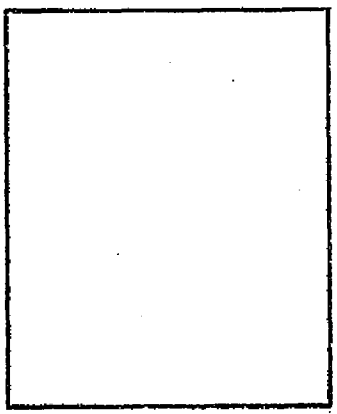


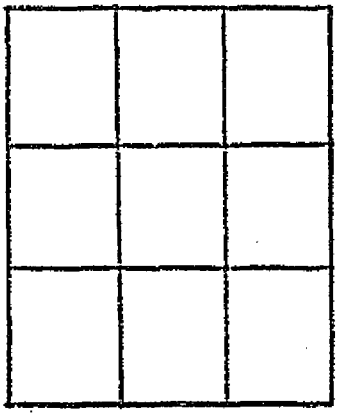
Crown Density of Trees and Brush

Divide area same as Land Use plot. Use peak of growing season. Estimate % coverage by trees and brush, as seen in full crown.

Aspect and Slope

Divide area as needed. Use only the aspects: N, NE, E, SE, S, SW, W, NW, L (level). Estimate slopes: 0%, 10%, 20%, etc.





LANDSAT classification of each 1.1 acre cell.
(May be filled in later).

Notes on data sources used in verification:

Notes on problems of location or classification of plot:

Notes on introducing LANDSAT cell data and making statistical comparison:

Multi-Source Map Compositing

Procedures for collecting ancillary data to be composited via computer with LANDSAT land use/cover maps were discussed at the January review meeting. Los Alamos Labs will be conducting the composite mapping analysis as part of their technical assistance role. Specifications outlined for the collection of data for further analysis include:

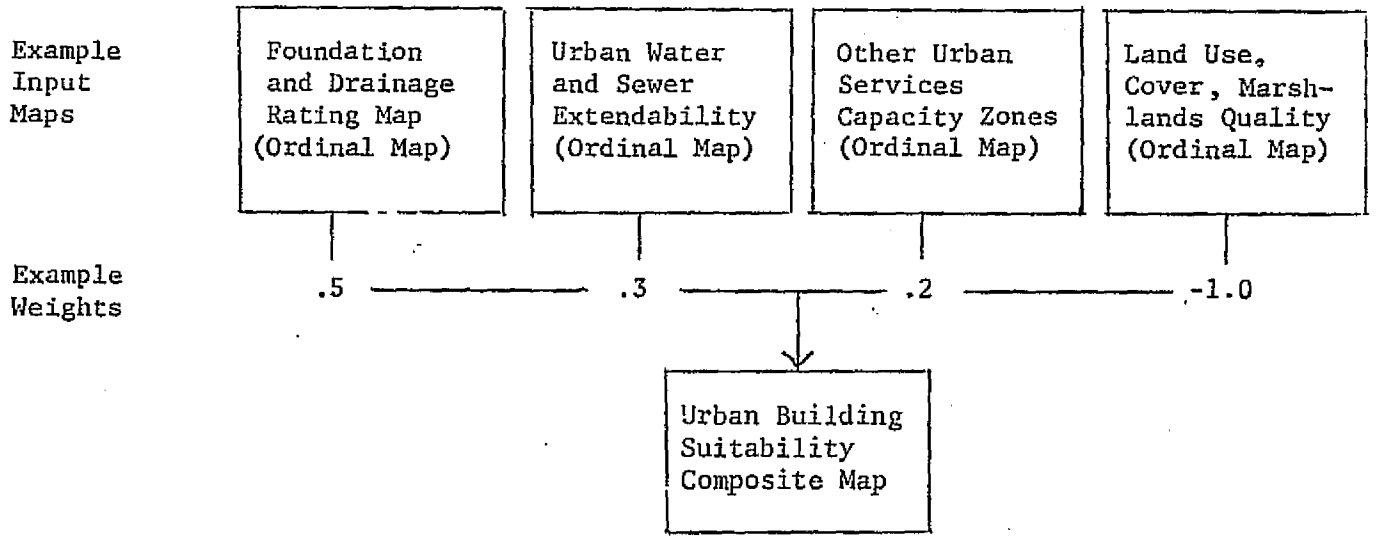
(1) the multi-source analysis problem will be on one quad per state;
(2) six to ten topic maps can be used, including the LANDSAT land use/cover map;
(3) analysis problems are to be relevant to current issues in the states;
(4) the state lead agencies will collect their data on 1:24,000 base maps;
(5) the states will code additional topic map data on CMS-type code sheets (these are rectangular cell code sheets, 8 cells by 10 cells per square inch);
(6) the states or the Federation will see that this coded material is keypunched for use by Los Alamos;
(7) the states will submit their materials to the Federation to be transferred to Los Alamos.

The purpose of this activity is to demonstrate the applicability of utilizing satellite remote sensing data in combination with other more commonly used data in planning and decision-making activities. Operational use of satellite remote sensing depends upon state and local governments' ability to combine remote sensing information with other data through standardized, inexpensive procedures.

Information to aid the state agencies in collecting information for map composite analysis has been distributed including several chapters of the Composite Mapping System II Users' Manual, illustrating applications of multi-source compositing and procedures for registering and coding data. The following Figure #1 and Forms C-1, C-2, and C-3 were also sent to the states to aid them in preparing additional information for further analysis.

Figure 1

Example: Flow Chart for Composite Map of "Urban Building Suitability"



Notes:

a. This example may be expanded by adding topic maps on Transportation Nodes, or Zoning, or other factors.

b. For this kind of exercise, it will be easiest to interpret and convert your input data into an ordinal scale of "urban suitability," less than 10 levels (suitability ranking). This will make the composite map a direct and logical result of combining the several ordinal maps. (See 6.3 concerning ordinal map legends.)

c. The relative map weighting is optional. It may be both positive (additive) or negative (subtractive). In this example, the fourth topic map on Land Use would rank the qualities of land use, giving higher ordinal ranking to such areas as high quality agriculture, forests, wetlands and floodlands, which should not be urbanized; then the negative weight (-1.0) would be assigned to the entire map, to counteract partly or completely the possible urban advantages of the other three topic maps.

d. For efficiency in coding these sector sheets, it is only necessary to encode the map changes, not each cell. This will cut out 90% of the manual labor. See the suggested encoding shortcuts in Chapter 4, Section 4.3.

State _____

C-1

Quad _____

FRMS LANDSAT PROJECT

STATE'S FLOW DIAGRAM OF COMPOSITE ANALYSIS
(See Example Fig. 1)

Practical Problem - Statement of problems to which this analysis applies.

CELL MAPPING AND COMPOSITING - SUPPLEMENTAL INFORMATION SHEET
(to be returned to the Federation)

State _____ Representative _____

Name of Test Quadrangle (1 of 4) _____

Date when grid sheets of new topics were submitted _____

Topic Maps	Source of Data	Desired Relative Weights	Has a separate sheet or Map Key been supplied for each Map?
Land/Use Cover	LANDSAT		
		(sum) 1.00	

DATA SCALE (MAP LEGEND) FOR EACH TOPIC MAP

TOPIC MAP TITLE _____		TOPIC MAP TITLE _____	
Sub-area characteristics (May be abbreviated titles)	Data Scale (Legend)	Sub-area characteristics (May be abbreviated titles)	Data Scale (Legend)
TOPIC MAP TITLE _____		TOPIC MAP TITLE _____	
Sub-area characteristics (May be abbreviated titles)	Data Scale (Legend)	Sub-area characteristics (May be abbreviated titles)	Data Scale (Legend)

Computer Processing of LANDSAT Digital Information

As reported in the Third Quarterly Report under the "New Technology" section, Colorado State University has been developing new pattern recognition software. This new software is designed for specific use with LANDSAT imagery for map and composite map overlaying, while maintaining low cost, ease of understanding, flexibility and exportability to users.

Presently LANDSAT land use/cover information is beginning to be processed at CSU based upon the verification work conducted by the states. The preliminary delivery schedule of classified LANDSAT land use/cover maps is:

State	Weeks Ending
New Mexico	May 7 & 14
Colorado	May 21 & 28
Utah	May 21 & 28
Wyoming	May 21 & 28
Montana	May 28 & June 4
Arizona	June 18 & 25

The following pages are an update of the flow chart of the LANDSAT Mapping System (LMS) developed by CSU.

LANDSAT MAPPING SYSTEM (LMS)

CURRENT STATUS OF DEVELOPMENT

This system is a total rewriting of the RECOG (RECOGnition Mapping System). This new system is compatible with RECOG, which was designed principally for training purposes. However, the new design is for specific use with LANDSAT imagery, for map and composite mapping system (CMS) overlay, low cost, ease in understanding, flexibility, export to other user computers, and high volume production.

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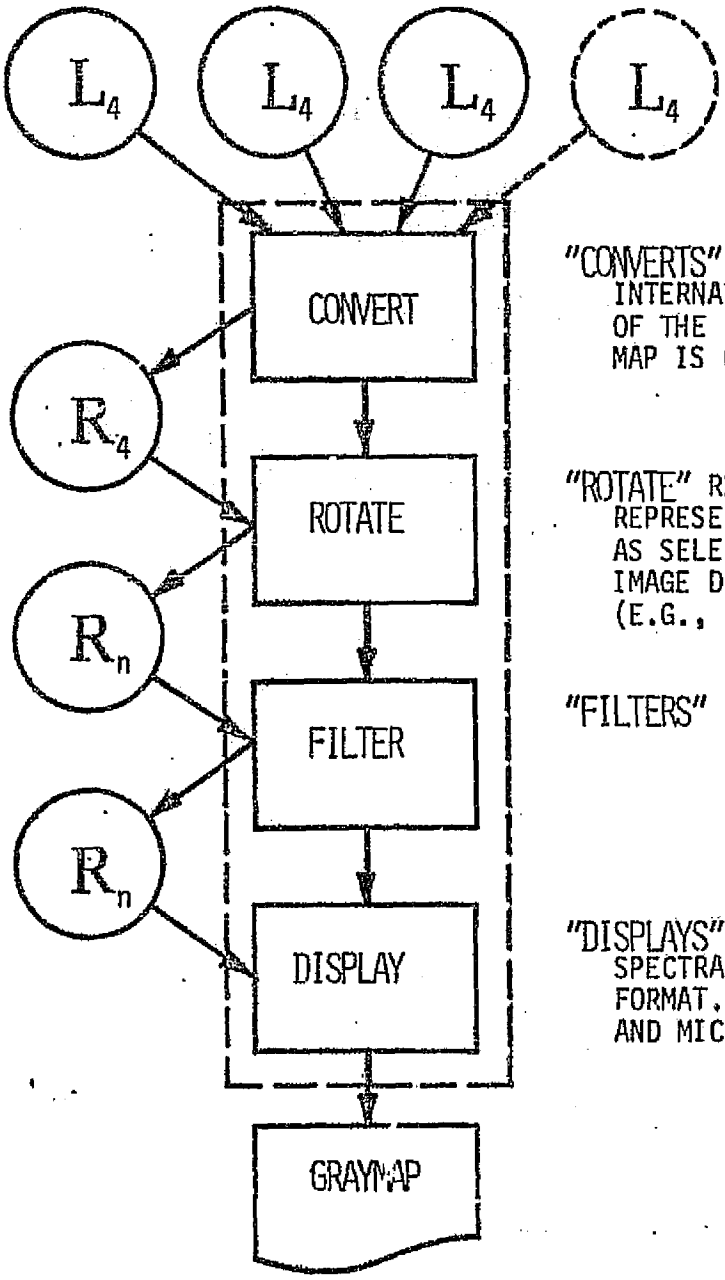
Fort Collins, Colorado 80523

Revised to: 1 April, 1976

STEP 1. IMAGE PREPARATION/MAP OVERLAY.



UP TO 4 TAPES, REPRESENTING ~25 MILE E-W SEGMENTS OF A GIVEN LANDSAT IMAGE, MAY BE INPUT SIMULTANEOUSLY.

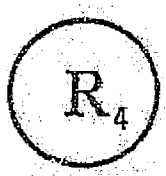
"CONVERTS" THE LANDSAT FORMAT TAPE(S) INTO THE INTERNAL, SINGLE RECOG TAPE. ONLY THE PORTION OF THE IMAGE NEEDED TO OVERLAY THE SELECTED MAP IS CONVERTED AND POOLED TOGETHER.

"ROTATE" RESAMPLES THE ORIGINAL IMAGE CELLS TO REPRESENT ANY SIZE RECTANGULAR OR SQUARE CELL AS SELECTED BY THE USER. ADJUSTS FOR ORIGINAL IMAGE DISTORTIONS. SCALES IMAGE TO MAP SCALE (E.G., 1:24,000).

"FILTERS" THE IMAGE.

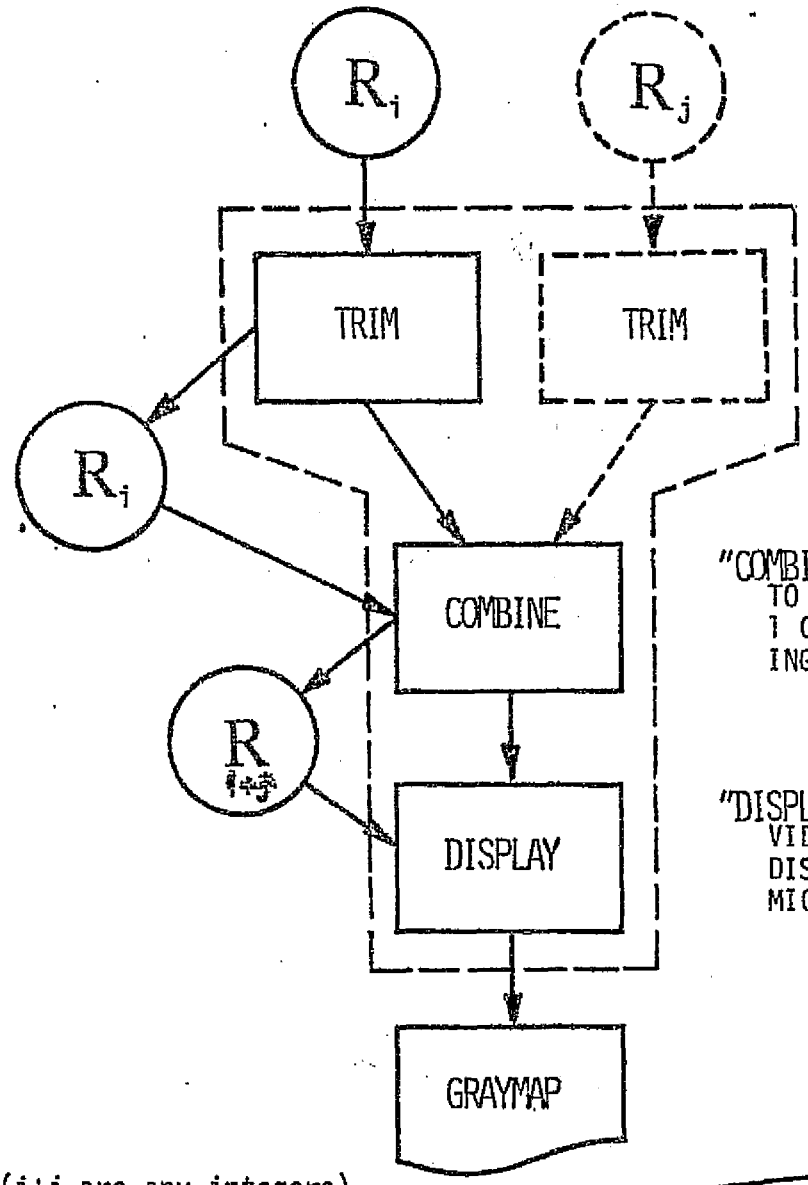
"DISPLAYS" 1, 2, 3 ... OR ALL OF THE INDIVIDUAL SPECTRAL BANDS IN THE ORIGINAL OR MAP OVERLAY FORMAT. DISPLAY OPTIONS INCLUDE LINEPRINTER AND MICROFILM GRAYMAPS.

"LANDSAT" COMPUTER COMPATIBLE TAPE (CCT) AS SUPPLIED BY EROS DATA CENTER.



"RECOG" FORMATTED TAPE (OR DISK) FILE - AS STANDARD FORMAT TAPE USED THROUGHOUT THE IMAGE PROCESSING ACTIVITY. (n = 1 to 4)

STEP 2. INTERLEAVES IMAGES FROM VARIOUS DATES.



UP TO 10 RECOG FORMATTED TAPES OF A VARYING NUMBER OF SPECTRAL BANDS ARE INPUT.

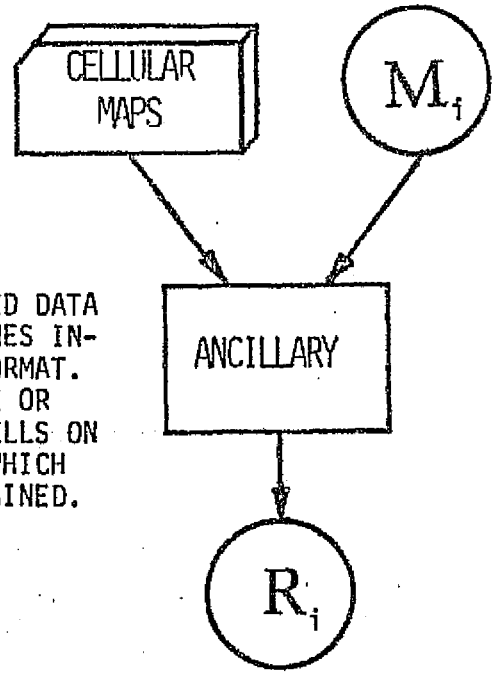
"TRIMS" EACH RECOG FORMATTED TAPE (OR FILE) TO A SELECTED NUMBER OF LINES AND COLUMNS DESIGNATED BY THE USER, USUALLY THOSE NEEDED TO COVER MAP SELECTED. LINES AND COLUMNS ARE RENUMBERED, BEGINNING AT 1,1.

"COMBINES" RECOG FORMATTED DATA FROM THE 1 TO 10 SEPARATE INPUT TAPES (FILES) INTO 1 COMPOSITE RECOG TAPE (FILE) REPRESENTING A MULTIDATE, MULTISPECTRAL IMAGE.

"DISPLAYS" 1, 2, 3 ... OR ALL OF THE INDIVIDUAL SPECTRAL BANDS IN COMBINED IMAGE. DISPLAY OPTIONS INCLUDE LINEPRINTER AND MICROFILM GRAYMAPS.

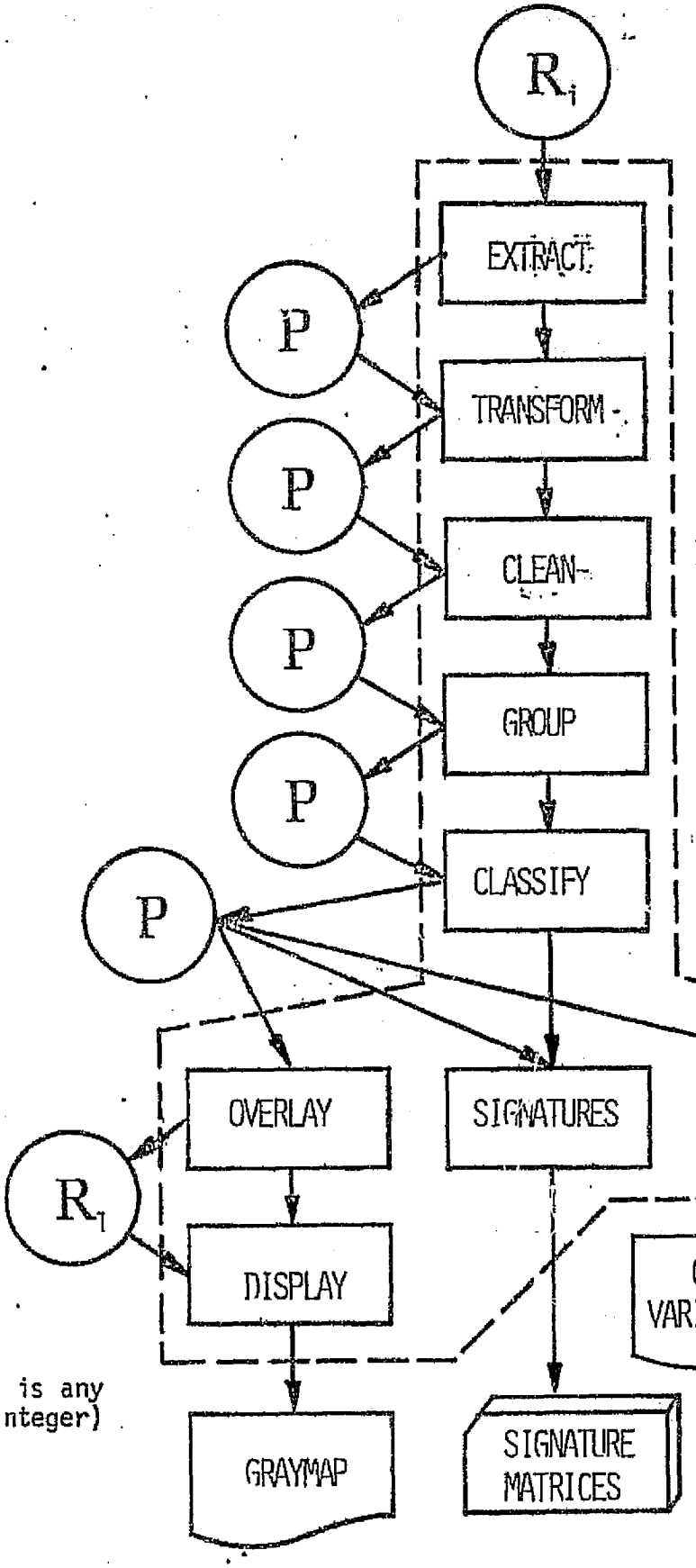
(i+j are any integers)

STEP 2. AUXILIARY PROGRAMS.



"ANCILLARY" CREATES RECOG FORMATTED DATA FROM CELLULARIZED MAP DATA PLANES INPUT IN CARD OR MAGNETIC TAPE FORMAT. MAP CELLS MUST BE THE SAME SIZE OR SOME INTEGER MULTIPLE OF THE CELLS ON THE RECOG FORMATTED DATA WITH WHICH THE ANCILLARY DATA WILL BE COMBINED.

STEP 5: COMPUTES STATISTICAL "SIGNATURES" OF MATERIALS TO BE MAPPED.



(i is any integer)

"EXTRACTS" THE TRAINING FIELD DATA IDENTIFIED BY THE USER (RECTANGLES, IRREGULAR AREAS, AND POINTS) FROM THE RECOG IMAGE FORMAT.

"TRANSFORMS" THE TRAINING FIELD DATA. FORMS RATIOS OF SPECIFIED SPECTRAL BANDS USES ELEVATION OVERLAYS TO ADJUST SPECTRAL BANDS FOR TERRAIN SHADOWING, ETC.

"CLEANS" OUT TRAINING FIELD DATA POINTS WIT LOW PROBABILITY OF BEING THE SELECTED MATERIAL OR HIGH PROBABILITY OF BEING SOME OTHER MATERIAL, ETC.

"GROUPS" TRAINING SETS TOGETHER WHICH WERE ORIGINALLY SELECTED IN EXTRACT TO REPRESENT SEPARATE MATERIALS BUT ARE NOW DETERMINED TO BE STATISTICALLY SIMILAR.

"CLASSIFIES" THE TRAINING FIELDS USING MAXIMUM-LIKELIHOOD APPROACH (STEPWISE DISCRIMINANT ANALYSIS). OTHER DECISION RULES CAN BE SUBSTITUTED HERE.

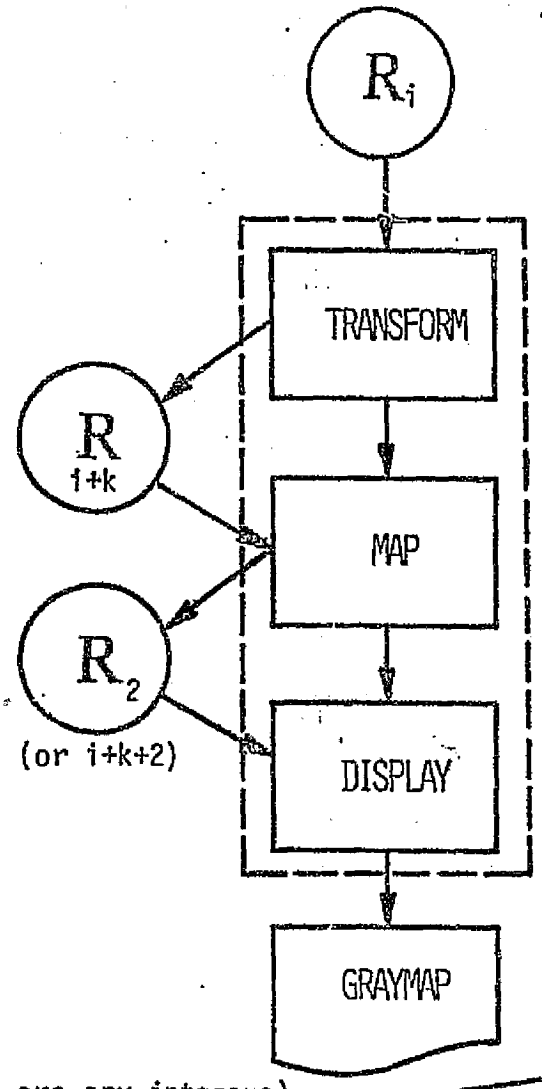
"OVERLAYS" ANY VARIABLE OR RESULT IN POINT FILE INTO A RECOG FORMAT FOR DISPLAY AND MAP OVERLAY.

"SIGNATURES" COMPUTES STATISTICAL REPRESENTATION OF EACH MATERIAL SPECIFIED BY THE USER FOR USE IN MAPPING THESE MATERIALS ON ANY DATA TAKEN FROM THE SAME ORIGINAL IMAGE.

"PRINTS" OR "PUNCHES" OUT ANY VARIABLE(S) IN THE POINT FILE FOR FURTHER ANALYSIS IN ADDITIONAL PROGRAMS WRITTEN BY THE USER.

"POINT" BY POINT TAPE (OR DISK) FILE. - AN INTERNAL TAPE, DISK, AND/OR CARD FILE FORMAT WHICH CONTAINS ONLY THE EXTRACTED TRAINING FIELD DATA AND DOES NOT MAINTAIN ITS CORRECT MAP OVERLAY POSITION.

STEP 4. MAPS DISTRIBUTION OF EACH MATERIAL.



"TRANSFORMS" DATA FOR EACH IMAGE CELL AS TESTED AND SELECTED IN STEP 3.

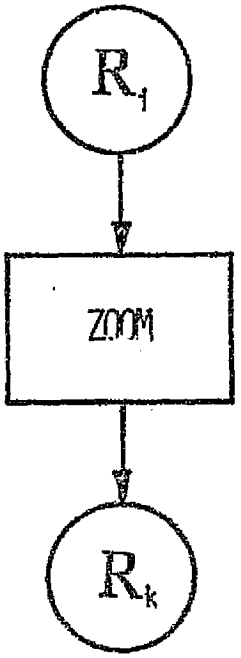
"MAPS" OUT THE DISTRIBUTION OF EACH SURFACE MATERIAL SPECIFIED BY THE USER.

"DISPLAYS" THE SELECTED IDENTIFICATION OF EACH IMAGE CELL AND/OR PROBABILITY THAT IT IS THE MATERIAL DESIGNATED. DISPLAY OPTIONS INCLUDE LINEPRINTER AND MICROFILM GRAYMAPS AND LINEPRINTER COLOR SYMBOL MAPS.

i and k are any integers)

STEP 4. AUXILIARY PROGRAM.

"ZOOMS" OR ENLARGES THE RECOG FORMATTED TAPE (OR FILE) BY ECHOING EACH IMAGE CELL "N" TIMES ON A LINE AND REPEATING EACH LINE "M" TIMES.



LANDSAT MAPPING SYSTEM (LMS)

ITEM	DEVELOPMENT STATUS		COST ESTIMATE*
CONVERT	100%		$5/date
ROTATE	100%		$7/date
FILTER	100%		$6/date
DISPLAY	100%	$1/band/date x 2 bands =	$2/date
STEP 1	100%		$20/date
Assuming 3 dates involved gives $20/date x 3 =			$60
TRIM	100%		$3/date
COMBINE	100%	3 dates combined =	$1
DISPLAY	100%	$1/band/date x 1 band =	$1
ANCILLARY	100%		optional
STEP 2	100%		
Assuming 3 dates gives $3/date x 3 dates + $1 + $1 =			$11
EXTRACT	100%		$10 (approx.)
TRANSFORM	100%		$5 (approx.)
CLEAN	100%	$2/iteration x 3 iterations =	$6 (approx.)
CLASSIFY	100%	$8/iteration x 3 iterations =	$24 (approx.)
SIGNATURES	100%		$2 (approx.)
OVERLAY	80%		optional
GROUP	70%		optional
PRINT/PUNCH	90%		optional
STEP 3	90%		
Based on 2,000 points =			$50 (approx.)
TRANSFORM	0%		$5 (approx.)
MAP	100%**	based on mapping 30 material types	$73 (approx.)
DISPLAY	100%**	black-and-white lineprinter symbol map	$1 (approx.)
ZOOM	0%		optional
STEP 4	75%		
Based on 30 classes mapped =			$79 (approx.)
		STEP TOTAL* =	$200 (approx.)

* Estimated computer costs for 1 of 1:24,000 quad map with:
- ~1 acre cells
- 3 dates (12 spectral bands)
- 2,000 cells defining training fields
- 30 material types
- black-and-white lineprinter display.

** Extensive modification needed to improve efficiency.

NEW TECHNOLOGY

For the past year, the Federation has been involved in a project parallel to the LANDSAT effort: the development of a new computer composite mapping system (CMS-II). That system and technical and user documentation have been completed and are being presently delivered to many users across the country. Requestors have thus far included local governments, state governments, federal agencies and universities.

CMS-II or a similar mapping system will be utilized at Los Alamos Laboratores for combining LANDSAT classified data with other multi-source information for specific land use planning problems. The Composite Mapping System-II has been designed to handle a variety of inputs, including conventional maps and aerial photos, reformatted LANDSAT tapes, point-polygon digitized tapes, socio-economic data on tapes and in tabular form and point sample data. The CMS-II system also allows for a variety of analyses, including interpretation of topic maps, weighting or assigning of values to data compositing numerous maps, providing statistical tables and histograms, accessing standard statistical packages to conduct multi-variate analyses on cellular maps, etc.

CMS-II is a cellular computer mapping program for compiling and analyzing natural resources and socio-economic data by public and private planners. Applications have included the production of maps showing the degree of environmental limitations to development, optimal locations for various industries, areas of greatest need for social services, areas of land use conflicts, statistical explanations of geographic related activities, and so on.

A further technical description and information on obtaining CMS-II is included in a Regional Technical Advisory in Appendix II of this report.

PROGRAM ON NEXT REPORTING INTERVAL

General activities during the next quarter, April 10 - July 10, will involve producing final LANDSAT land use/cover classification maps, generating multi-source data for compositing and initiating final report efforts. Specific activities proposed for the next few months include:

(1) final verification of LANDSAT data by the state lead agencies,
(2) final production of LANDSAT land use/cover maps by Colorado State University--according to the previously announced schedule,
(3) completion of multi-source data collection efforts by state agencies for computer compositing with LANDSAT information by Los Alamos,
(4) Los Alamos Laboratories will initiate composite mapping analyses according to state guidelines.
(5) a meeting of project participants only is scheduled for June 7, 8, to review activites to date, LANDSAT products and to determine a format for the final reporting.

CONCLUSIONS

A. Standard procedures have been developed for the identification of LANDSAT verification procedures and for collecting information for multi-source map compositing. The state lead agencies are now working on these data collections.
B. Colorado State University and the Federation have completed or nearly completed new software programs for analyzing multi-source and LANDSAT digital information.
C. A project review meeting held in January was well attended and produced significant decisions for follow-up on the LANDSAT project.

RECOMMENDATIONS

A. We have no new recommendations at this time.

APPENDIX

(Included in NASA editions only)

I. January Earth Resources Meeting Report

II. Composite Mapping System II Technical Advisory

MEETING REPORT
AD HOC EARTH RESOURCES TECHNOLOGY APPLICATIONS COMMITTEE

January 13, 14, 1976
Denver, Colorado

I. ATTENDEES

Attached is a complete list of the names and addresses of those in attendance during the two-day session.

II. OBJECTIVES

A. To provide an overview and an update on the Federation's LANDSAT project.

B. To review and comment on the work of Colorado State University on the LANDSAT project.

C. To discuss the participation of Los Alamos Scientific Laboratory on the LANDSAT project.

D. To discuss the state activities related to the LANDSAT project.

E. To formulate the next steps on the LANDSAT project, including the initiation of an outline of a final report to NASA.

F. To discuss the scope of the Federation's CMS-II computer mapping package and announce its availability.

G. To exchange information regarding the activities of each participant in the area of remote sensing and geographic information systems.

III. RESULTING FOLLOW-UP ACTIVITIES

A. Future Meetings

1. A session with the active participants of the project will be held this spring, hopefully in early April. The purpose of this meeting will be to review Colorado State University's land use output maps, to discuss state verification procedures, to discuss data collection and analysis schemes for multi-source compositing problems, and to initiate the design and work on a final project report.

2. The next general review session, including all participants, the ad hoc Earth Resources Technology Applications committee, and interested persons, will be held late this summer when a draft of the final report will be available for review. It is proposed that this meeting be held at or near Los Alamos, New Mexico, so that attendees may visit the laboratory.

3. Arizona and Colorado yet need to arrange for interagency meetings to discuss the project and possible relevant analyses for the test areas. These should be held in the next three months.

B. Colorado State University Follow-up

1. Eugene Maxwell will produce and distribute a paper on the verification process to be used by state lead agencies in evaluating the land use maps produced from LANDSAT data. That paper will outline procedures and give options for selecting statistically satisfactory verification procedures. Dr. Maxwell will communicate with each state lead agency representative and settle upon a verification process.

2. Within the next few weeks, CSU will produce and distribute the land use maps for the test quads in the states.

3. CSU will also work with the Federation toward developing more frequent and more comprehensive reports to project participants.

C. Federation Follow-up

1. Doug Mutter will send CMS cellular code sheets to the state lead agencies for possible use in designating verification sites and for initial coding of additional multi-source data for computer analysis.

2. The Federation will be responsible for distributing periodic status reports with milestones indicated for all participant efforts in the project.

3. An announcement of the availability of CMS-II program package will be sent out in the next few weeks.

4. Doug Mutter will also distribute to lead agencies a proposed format for collecting and presenting data to Los Alamos for multi-source computer mapping and analysis purposes.

5. The Federation may send out a questionnaire to determine needs for joint regional efforts in applications of this technology.

D. State Follow-up

1. State lead agencies, upon receipt of CSU verification materials, will proceed with discussions with CSU and with verifying the land use output maps.

2. They are also to communicate with CSU and fill any gaps in ground truth data for their test sites.

3. They are to continue to work with interagency users in the state and encourage their participation in formulating relevant compositing procedures.

4. The states are to initiate data collection for fulfilling the requirements for multi-source map analyses--the next project step. This activity is to be well underway by the first of April.

E. Response to state comments on the following four items, asked by chairman Keith Turner, will be as follows:

1. Communications with CSU: Will be more frequent through a periodic reporting procedure. CSU will produce the land use output and get those out to the lead agency representatives and will provide lead agency representatives with additional information on individual quadrangle progress.

2. Related agency interests: States will continue to encourage interagency participation in supplying data and formulating multi-source needs. Colorado and Arizona will hold interagency meetings within the next three months (to be coordinated with the Federation). State and local agencies should also be involved in evaluating project activities for the final report; this will be the responsibility of individual lead agency representatives.

3. Poor U-2 coverage: This will be brought to the attention of NASA through the Quarterly Report produced by the Federation, and also via a special letter to NASA (Goddard and AMES) and EROS. Because of the lateness in the project, a corrective flight will not be requested.

4. A ground truth manual: This will be suggested in Federation Quarterly Reports to NASA and in the final report as a possible add-on project. (Possible add-ons to this project are a. a ground truth and test site verification manual, and b. the refinement and marketing of CSU software on the LANDSAT Mapping System.)

IV. MEETING SUMMARY

A. The meeting was opened by Michael Annison, Executive Vice-President of the Federation. Mike discussed the role of regionalism in the development of national goals and policies. He specifically noted that federal investments and R & D policies failed to strengthen and support the Rocky Mountain Region.

B. Doug Mutter, Director of Federation Council Operations, provided a brief background and overview of the Federation's LANDSAT project; he outlined the general objectives as being:

1. to develop interstate cooperation and the utilization of satellite-based earth resources information,
2. to strive towards the development of compatible interagency and interstate information systems,
3. to adapt and test a modified U. S. Geological Survey land use classification,
4. to evaluate the efficiency of a multi-source land use information system and specifically the satellite information, and
5. to provide a medium of information exchange on remote sensing and geo-information systems.

C. Keith Turner, Chairman of the Ad Hoc Committee on Earth Resources Technology Applications, provided a more detailed project history. He discussed the role of various project participants, including the six states of Arizona, Colorado, Montana, New Mexico, Utah, and Wyoming; the technical contractor, Colorado State University; the Earth Resources Committee; the Federation; and Los Alamos Scientific Laboratory. He suggested the development of a satellite data users handbook as possible future work. He also suggested that we start thinking about our final report to NASA which will be due in October; and that possibly we should have our summer final review meeting at or near Los Alamos Laboratory so that the group could review their facilities and capabilities. (The attached project Briefing Paper contains additional information.)

D. Lee Miller, from Colorado State University, discussed the role of CSU in the LANDSAT project. He noted that he was involved with input/output and software redesign efforts, while Eugene Maxwell, also of CSU, was involved with training data and production efforts. Lee provided a brief background history of the software development and stated that the third generation program, LANDSAT Mapping System, (LMS), was nearly completed. Lee reviewed the functions of LMS (detailed flow-chart attached), and he estimates total computer processing costs at approximately $200. This excludes the cost of the LANDSAT computer compatible tapes

(CCT's) which are about $200, the internal tape cost, which would be about $15 each, and the ground truth verification costs, which are highly variable. For use with computer outputs, Lee suggested the use of USGS 1:24,000 quad sheet overlays that the states could obtain for about $20 each.

E. Eugene Maxwell discussed ground truth analysis progress, and described the relative success in detecting various land use categories. He noted that CSU was about a month behind in the project, due to slow receipt of some ground truth data and reprogramming of LMS; but that land use maps on several of the quads would be available in the next few weeks. He also noted that the more extensive use of computer software has reduced the human involvement in evaluating training site data and, therefore, has reduced the error. Eugene said that there were some gaps that needed to be filled in the training data from the states before complete signature analysis was possible and that he and the state lead agency representatives should communicate on this. He emphasized that the quality of the ground truth information would have a direct bearing on how good the final computer maps were.

Two separate activities which the states are involved in were discussed:

1. the collection of training site and ground truth information, which has already been completed by the states, and
2. the verification of the computer maps, which will be conducted next.

The group discussed at length the verification process and the need for statistical validity in this effort. It was suggested that a ten percent sample be taken (for example, 300 groups of 9 cells--10 acres each--should be randomly selected as verification sites). CSU offered to generate a random scatter of verification sites for each state and then send it to each state as a printed overlay, showing all random cell locations in each quad.

There may be some access constraints that the states wish to consider; those must be decided upon before the generation of this random scatter. Another option was that the states themselves randomly select the verification sites, utilizing a grid overlay of eight cells per inch vertically, ten cells per inch horizontally, with the first cell beginning in the upper left corner of the quadrangle (the CMS sector grid cells would be ideal for this process).

The result of this discussion was that Doug Mutter would send to the states several CMS sector grid cell sheets, if they decided to use this process; and that Eugene Maxwell would send out a paper to state lead agencies on what the options are for this verification process, explaining each one, and would then communicate with each lead agency representative to decide on a standard process.

F. George Nez, FRMS consultant and project principal investigator, reviewed the activities of a related effort being conducted in North Carolina. They are developing a cellular, computer based, statewide geographic information system.

G. Keith Turner invited state lead agency representatives to comment on several aspects of the project:

1. communications with and work of CSU,
2. related agency interest in each state,
3. quality of the U-2 coverage of the text sites,
4. their experience in the collection of ground truth data and the possible need for ground truth users manual.

Arizona's response by John Milner:

1. CSU communications - Fine! Mostly by phone presently; a meeting would be useful later.
2. Agency interest - Starting to build up, including regional planning groups, state departments of transportation, economic planning, and lands.
3. U-2 coverage - Did not use the U-2 coverage supplied under this project, but used excellent color IR, MSS, black-and-white and ortho-photos on test areas.
4. Ground truth - Did a lot of original work and are now developing a ground truth library which could be expanded. A manual would be of limited use now, but could be used in the future and in other agencies.

Colorado's response by Keith Turner and Eugene Maxwell:

1. CSU communications - No problems since CSU is doing the ground truth.
2. Agency interest - No formal activity yet; however, Jim Getter of the Colorado State Forest Service is conducting a survey of state agencies which is due in February and possibly a joint session could be conducted.
3. U-2 coverage - Poor in the flat areas; mountain and hilly areas pretty good.
4. Ground truth - CSU is doing the ground truth; they strongly advocate a manual as possibly a follow-up project.

Montana's response by Tom Dundas and Doug Mutter:

1. CSU communications - No information available, good under original lead agency representative.
2. Agency interest - One meeting has been held with 19 persons of various state and federal agencies.
3. U-2 coverage - Unknown.
4. Ground truth - Adequately prepared by Scott Fisher before his departure. The next problem will be verification procedure.

New Mexico's response by Mike Inglis:

1. CSU communications - Need more communication and need to obtain some output and find out more about what CSU is doing.
2. Agency interest - Held a meeting which involved the state planning agency, Department of Highways, Bureau of Mines, State Geologist, Bureau of Land Management and some Santa Fe planning groups. Feels that products are needed for the next go-around.
3. U-2 coverage - Terrible! The flight lines are way off; the coverage is very, very poor.
4. Ground truth - Have collected a lot of good ground truth information, especially with the help of the Bureau of Land Management and U. S. Forest Service. A ground truth manual is necessary as a follow-up project, especially because of personnel turnover at state agencies.

Utah's response by Merrill Ridd

1. CSU communications - Good and effective. Looking forward to receiving print-outs and paper on sampling procedures.
2. Agency interest - Discouraged at the present time, although two meetings have taken place and included several state and federal agencies. Those most interested are the U. S. Forest Service, State Department of Natural Resources, Wildlife people, State Transportation people, State Conservation people, and two county planning groups. Feels that products are needed to get more people involved. Merrill mentioned that the University's Remote Sensing and Cartography Center has been working for two years in the area of user interest.
3. U-2 coverage - Good coverage, but the flight lines are off. RC-10 and HR-732 coverage was off line.
4. Ground truth - Definitely a manual is needed. Have collected good ground truth and verification data.

Wyoming's response by Larry Ostresh:

1. CSU communications - Has been pretty good through phone and visits, but needs more information on what they're doing.
2. Agency interest - Has had a lot of help from state and federal agencies. Those involved have been State Geologist, U. S. Forest Service, Bureau of Land Management, Wyoming Land Use Department, ASCS, and SCS--both of these have been helpful on ground truth--Department of Economic Planning, Wyoming Planning Association, and Departments of Highway and Environment. The Wyoming Mapping Group is interested in developing a central geographic information system. State Geologist voiced skepticism in this type of a project.
3. U-2 coverage - Noted that he did not have very good coverage of his area.
4. Ground truth - Felt that this is very much needed and noted that he had help on ground truth collection from the SCS, ASCS, USFS, and BLM.

H. Keith Turner continued, discussing the need for more frequent knowledge for the participants on the status of different parts of the project, especially CSU's work and that product maps were needed as soon as possible by the state agencies. He suggested a periodic reporting procedure, utilizing a bar chart or milestone chart for the progress of this project. The Federation and Colorado State University will put this together.

I. Keith Turner then opened the session to discussion by various participants of their activities:

1. Gene Maxwell and Merrill Ridd discussed a series of workshops which they were jointly starting on remote sensing in the Rocky Mountain region. The first will be March 18 and 19, at Colorado State University. The next will be later in the year and be more applications oriented, while the first will be a technical session. They suggested perhaps one of each of these types of symposium each year be held somewhere in the region, and that perhaps these could be coordinated through the Federation and operated by the universities.

2. Jim Plasker and Mac Strain of the U. S. Geological Survey discussed the USGS' work, especially in digitizing land use tapes, and the creation of the national cartographic information center as a clearing house for remote sensing and mapping information. They also discussed the metric mapping system that USGS is moving toward and emphasized their activities related to state mapping and information needs.

3. Tom Dundas outlined the activities of the Research and Information Systems Division of the Department of Community Affairs in Montana. He identified some of the many areas where the Division is collecting a library of digitized information, including: jurisdictional boundaries, land ownership, pipelines and roadways, section corners, subdivisions, recreation areas, natural gas and crude oil production data, and economic and social information.

   He noted that they can select various geographic reference systems for output (latitude/longitude, UTM's, township range, etc.). He also mentioned that they were starting to work with USGS on the development of land use and cartographic file for the state and that Montana has an active state mapping advisory committee; also that they have a library file on all state statutes and monitor of all federal grants in the state; that they have been designated as a processing agency by the Bureau of Census and the Bureau of Economic Analysis; and that they were conducting an Old-West Commission project in the area of our LANDSAT test sites.

J. Phil Burgess, Federation Executive Director, discussed research and technology utilization in State Government. Phil noted that even though money for research and development to the states has risen in recent years, it still comprises a small portion of the total national R & D budget. He stated that technicians needed to be involved in political decision-making processes because this is where technology utilization often begins. Phil specifically asked for feedback from the states on what should be done to promote states' capacity to accomplish needed tasks. He noted that there were also two principal problems in utilization of science and technology by the public sector:

   1. that of market aggregation; for example, to get users together to demonstrate the applicability of science and technology; and
   2. need of a mechanism to exchange information on a continuous basis and to provide continuous technical assistance.

   Phil suggested that the Federation send out a questionnaire on this subject.

   Some comments during the ensuing discussion were:

   ..the need to attach technology utilization to a prime issue or situation;
   ..the need to involve and educate state legislatures;
   ..the technology transfer process needs a long term perspective from both the technical supply agency and the support or demand groups;

..a marketing system needs to be set up for collection and dissemination of information;
..a regional group could provide support for state people to collect information and transfer it to other states;
..user group meetings are useful; Utah had some experiences in this area;
..the Federation will periodically send out technical advisories on what other states are doing in specific areas;
..university and state relationships must be tied more closely together;
..a part of the R & D budget should be for technology transfer and communication;
..universities often initiate but cannot follow through with technology implementation.

K. Dick Vogel, of Los Alamos Scientific Laboratory, discussed LASL's energy-related regional studies program for applying their technology to problems and issues of the Rocky Mountain Region. Dick focused his discussion on LASL's emerging computer mapping and analysis capabilities and specifically on their versatile systems for data display. LASL's role in the LANDSAT project is a supportive technical assistance one. LASL will be conducting the computer analysis required by the states under this project, but needs specifications, including production time, data format, amount of data, and specifics on relevant problems for analysis.

After discussion, it was decided that Doug Mutter would send out a preliminary paper on format, but that it would probably include:

1. The analysis problem will be on one quad.
2. Six to ten topic maps can be used.
3. Analysis problems will be relevant to current issues.
4. The state will collect their data on 1:24,000 base maps.
5. States will code this material onto CMS-type code sheets.
6. The Federation will see that this material is keypunched for use by LASL.

L. Doug Mutter provided a brief introduction to the CMS-II mapping program, noting that it is a cellular program adopted for IBM-OS systems, that it is based on COBOL language and is set up for a machine memory core of 150K bytes (decimal). He said that a program tape, a systems documentation report, and a users manual would be announced soon, and that a cost of this package would be in the neighborhood of $250. Prior to obtaining the package, an interested party must obtain a release agreement from the Economic Development Administration by writing to:

Mr. John Fieser, Program Planning Division, Economic Development Administration, Main Commerce Building, Room 6100, Washington, DC 20230.

M. George Nez then provided additional detail on the background history, applications, and scope of the CMS-II mapping program. This is outlined in the attached draft of Chapter 1.0 of the CMS-II Users Manual.

N. Robert Hansen of the U. S. Bureau of Reclamation discussed the Bureau's activities on the James River area of South Dakota. They are using the CMS mapping program to accomplish an environmental analysis of the region. They are presently inputting data including a 21-category land use map and will be doing further analysis in the near future. He also mentioned that the Bureau of Reclamation has 100 terminals located in the Rocky Mountain region which could all utilize the CMS program based at their Denver computer center.

O. George Nez reviewed a draft outline of criteria for the final LANDSAT project report (attached for your information). George reviewed in detail the section concerning state requirements. He emphasized the need for the states to include the following in their individual reports:

1. a description of the test quadrangle,
2. discussion of land use cover categories,
3. ground truth collection,
4. usefulness of LANDSAT information,
5. other data and multi-source compositing problems,
6. cellular mapping applications, and
7. progress on regional data banking.

The group discussed the evaluation table in the outline and suggested that state and local decision-makers be involved in evaluating this project, as this might increase its future applications. It was also mentioned that this final report would be marketing document for further NASA earth satellite applications programs.

P. It was suggested that a meeting be held this spring for the active participants of the project, about a month after products from CSU were sent to the states. At this time (perhaps about the first of April), the participants would discuss verification problems, would have an idea for further composting analysis and would already have begun data collection and would have a better idea about development of the final report.

V. ATTACHMENTS

A. List of Attendees
B. Project Briefing Paper
C. LANDSAT Mapping System
D. Computer Mapping System
E. Project Final Report Outline

Attachment A

Attendees - ERTA Meeting, Continental Denver - January 23, 14, 1976

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From FRMS:

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**Federation of
Rocky Mountain States, Inc.**

BRIEFING MATERIALS

for

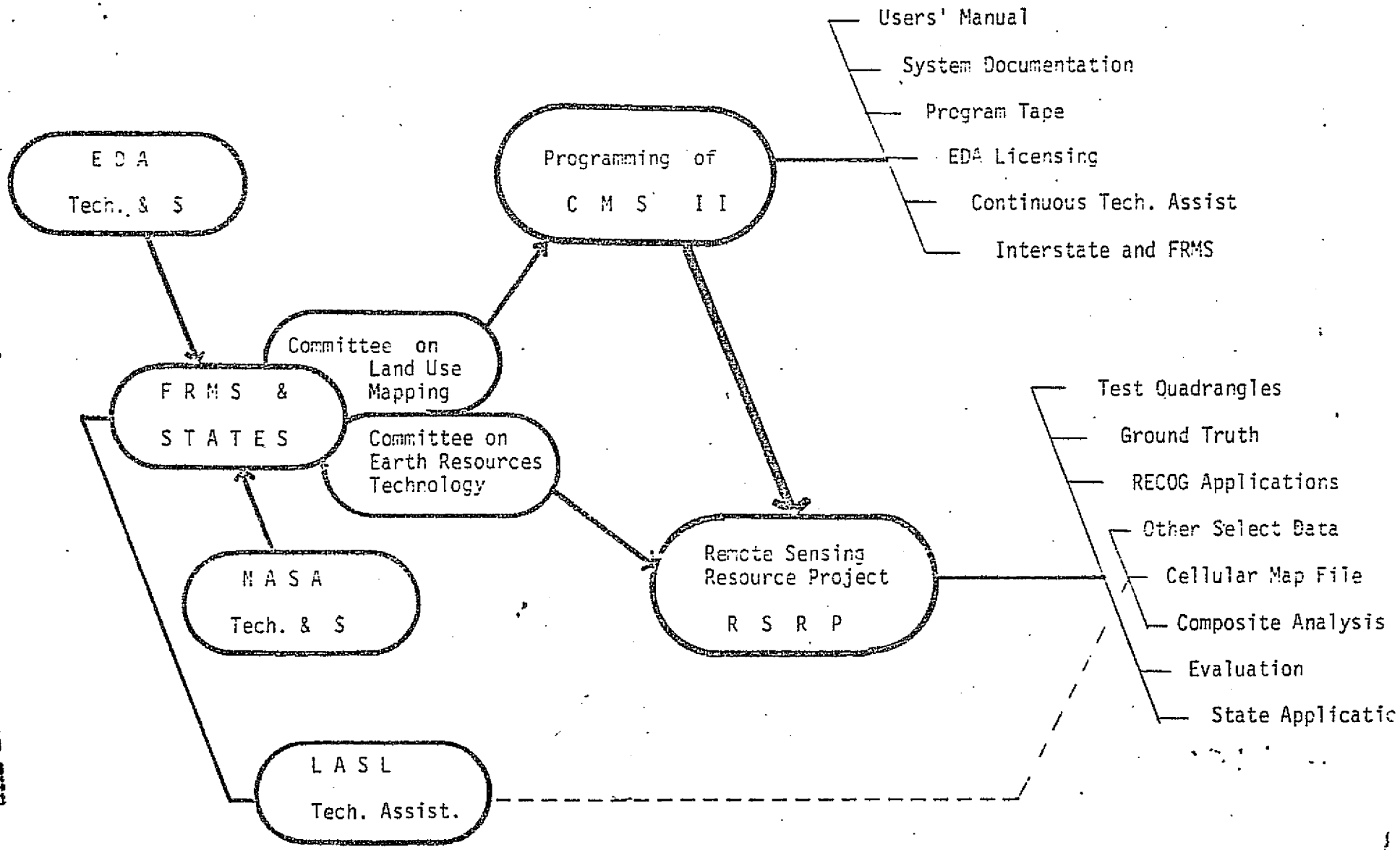
FEDERATION OF ROCKY MOUNTAIN STATES, INC.

LANDSAT AND GEOGRAPHIC ANALYSIS ACTIVITIES

CONTENTS

COMPLEMENTARY PROJECTS

Federation of R. M. States - Conference April 7, 8, 9



Project Statement - (1) To demonstrate the application of satellite generated earth resources information as part of a continuous land use information survey system; (2) specifically, to (a) produce satellite generated land use maps on four 1:24,000 quadrangles in each of the six states, (b) directly involve the states in data collection, analysis, and evaluation, (c) collect and analyze additional data via a computerized cell mapping program, (d) involve a variety of users from the Rocky Mountain region, and (e) generate a final report including an evaluation of this type of process for land use planning.

Objectives - (1) To encourage interstate cooperation in the utilization of earth resources satellite technology for solving land use planning problems; (2) to discuss and work toward the development of compatible inter-agency, interstate information system procedures; (3) to adopt and test a common land use classification; (4) to evaluate the efficiency of a land use information system, utilizing satellite and other data; and (5) to provide a medium for information exchange concerning remote sensing and geo-information systems.

The states involved are:

Arizona - Carl Winneka, Arizona Resources Information System
Colorado - Tom Vogenthaller, Colorado Energy Research Institute
Montana - Albert Tsao, Energy Planning Division
New Mexico - Frank Kottlowski, State Bureau of Mines
Utah - Merrill Ridd, Department of Geography, University of Utah
Wyoming - Larry Ostresh, Department of Geography, University of Wyoming

The technical subcontractor for analysis of the LANDSAT satellite information is Colorado State University - Lee Miller, Eugene Maxwell.

The Federation of Rocky Mountain States is acting as manager and coordinator of the project and is responsible for administration and report writing - Doug Mutter, George Nez. The Federation's ad hoc commitee on Earth Resources Technology Applications - Keith Turner, Chairman - is acting as review and advisory body to the project.

Los Alamos Scientific Laboratories is offering technical assistance in the computer analysis of data--Dick Vogel.

Budget - Total project budget is $178,000, funded by NASA; each of the six states receives $10,500; Colorado State University receives $89,000; and the Federacion receives $26,000.

Meetings - Two general review meetings have been held in the past year, involving more than 50 persons from around the region. Six different meetings, involving 60 persons (potential users) have been held in most of the states. We anticipate one meeting this spring of project participants and a final review meeting this summer.

Project Status - The project began April, 1975, and will run through October, 1976, for a total of eighteen months. States have collected and submitted ground truth information to the technical subcontractor, Colorado State University, who is now in the process of compiling first-round land use maps from satellite data. The states are also in the process of collecting additional information and formulating additional land use planning analysis problems. Our second review meeting was held January 13-14. The project is close to schedule.

LANDSAT
PROJECT ORGANIZATION

Federation of Rocky Mountain States, Inc.

REVIEW/ADVISORY

Ad Hoc Committee on Earth Resources Technology Applications

Keith Turner, Chairman

PROJECT MANAGEMENT
FRMS
Doug Mutter

Principal Investigator
George Nez

STATE | WORK UNITS

COLORADO
Colorado Energy Research Institute
Tom Vogenthaller

ARIZONA
Arizona Resources Information System
Carl Winneka

MONTANA
Energy Planning Division
Albert Tsao

NEW MEXICO
State Bureau of Mines
Frank Kottlowski

UTAH
University of Utah
Merrill Ridd

WYOMING
University of Wyoming
Larry Ostresh

PROCESSING

COLORADO STATE UNIVERSITY

Lee D. Miller
Department of Civil Engineering

Eugene Maxwell
Department of Earth Resources

CONSULTATION AND ASSISTANCE ON COMPUTER ANALYSIS

LOS ALAMOS SCIENTIFIC LABORATORY

Dick Vogel

LANDSAT PROJECT

WORK PLAN

A. PROCURE & PREPARE DATA

..LANDSAT CCT's
..Overflights (aircraft)
..Ground Truth
..Training Sites

B. LAND USE IDENTIFICATION AND VERIFICATION

..Statistical Analysis
..Field Verification
..Signature Identification

C. MAPPING LAND USE/ COVER

..Production of Maps (1.1 acres, 1:24,000)
..Overlays
..Evaluation

D. ANCILLARY DATA COLLECTION

..Determine Comprehensive Analysis
..Collect Data
..Assign Values

E. COMPOSITE MAPPING

..Assemble & Code Data
..Run Computer Analysis
..Produce Composite Maps

F. EVALUATION AND FINAL REPORTING

..Evaluate Aspects of Project
..Reports from Participants
..Assess Usefulness of Techniques
..Final Report & Dissemination

FRM& LANDSAT PROJECT

SCOPE

The scope of the work for this project has been altered from that originally proposed[1/] in order to conform to reduced NASA funding. The revised program has been developed under the guidance of the Ad Hoc Committee on Earth Resources Technology Applications, Federation of Rocky Mountain States.

GENERAL OBJECTIVES

The broadest objectives are to develop interstate cooperation in the utilization of ERTS data and to activate compatible state and federal systems for surveying and analyzing land use and other regional resources. These are urgently needed in the Rocky Mountain region, where there is an intermingled pattern of federal, state, utility and private lands. The potentially rapid and low cost coverage by ERTS and other remote sensing would meet urgent needs of several area resource planning programs. And the potential of repetitive coverage would be particularly important in view of the seasonal changes in agriculture, water production from snow and high forests, mining, recreation activities, seasonal residence, seasonal transportation loading, etc.

The current users of such coverage would include federal, state and local governments, and basic industries. The energy crisis is only the latest planning problem to join the list requiring the ERTS type of regional coverage.

1/ "A Continuous Regional Land Use Survey System" proposed in January, 1973 by the Federation of Rocky Mountain States, would have covered 6 times more test area, and included many socio-economic topics along with the surficial land uses.

Behind this ERTS project there are already many regional and federal area planning efforts and substantial technical experience in geographic multi-variate analysis and simulation 2/, so the project is overdue.

Another general objective is to adapt the USGS recommended land use classification, first and second levels, to fit the resources and management problems of the region.

Then it will be possible to blend the survey data and capabilities of the several states and federal agencies into a common working system of land use analysis, which may be extended over larger regions and entire states.

Finally, the project will evaluate the comparative efficiency of this ERTS-based continuous survey system in terms of currency, rapidity, accuracy, analytic versatility and costs.

2/ Relevant example studies which have been performed by the Federation and/or states of the region:

a. The Implementation of Computer Composite Mapping for Efficient Industrial Locations in the Four Corners Commission, Bureau of Economic Research, Univ. of Utah.
b. Using Computer Mapping and Multiple Regression for Gauging the Relationship of Various Investments to Inter-County Changes in Economic Level, G. Nez and C. V. Crittenden, EDA, U.S. Department of Commerce, Washington, D.C. 1970.
c. Computer Assisted Mapping of Local Needs for Certain Health Services in Arizona, G. Rockwood and G. Nez, Bur. Econ. Research, Univ. of Utah, 1972.
d. Evironmental/Economic Modelling by Means of Computer Composite Mapping, Dept. Forestry, Colo. State Univ, and Federation of Rocky Mountain States, reported by L. J. Salmen, 1972.
e. County-wide Evaluation of Areas of Optimal Available Open Space for Public Purchase, Federation of Rocky Mountain States and USGS RALI program, 1973-74.
f. Existing and Potential Areas of Competition Between Divergent Land Uses, Federation of Rocky Mountain States for Wyo. Conservation and Land Use Study Commission in 1974.
g. A Multi-Variate Analysis of Coal Strip Mining and Land Reclamation Feasibility in Kemmerer County, Wyoming, 1972.

SPECIFIC OBJECTIVES

Each of six Rocky Mountain states (Colorado, Arizona, Montana, New Mexico, Utah and Wyoming) will designate a state lead agency. The agencies will have a dual responsibility - to provide interstate technical representation and to coordinate their home-state work.

Three large test sites of approximately 50 x 150 miles have been specified, in locations of characteristic resources and management problems, (See Fig. 1 - Approximate Locations of Test Sites)

A standard land use classification system is under consideration within the Rocky Mountain region, to be based on the recent USGS recommended system for use with standardized remote sensing outputs. See Fig. 2 - Standard Land Use Classification. Now, more work is needed on the second order classifications, which depend upon auxilliary data from high flight and ground surveys. This project will determine the feasibility of using such auxilliary data for regular, repetitive surveys of the second order land uses, and will also determine a practical grid cell size for these uses. It is proposed to begin with 10 acre cells for the most exacting local planning purposes, and 40 acre cells for extensive regional analyses and future change simulation. (1.1 acre cells are actually being used). The project will test the feasibility of nesting these grids so that the data in the finer cells for selected localities may be aggregated into the larger cells, for analysis over regions. At this regional level, much social, economic and resource data comes in very gross resolution, so that a regional data file need only plot large cells.

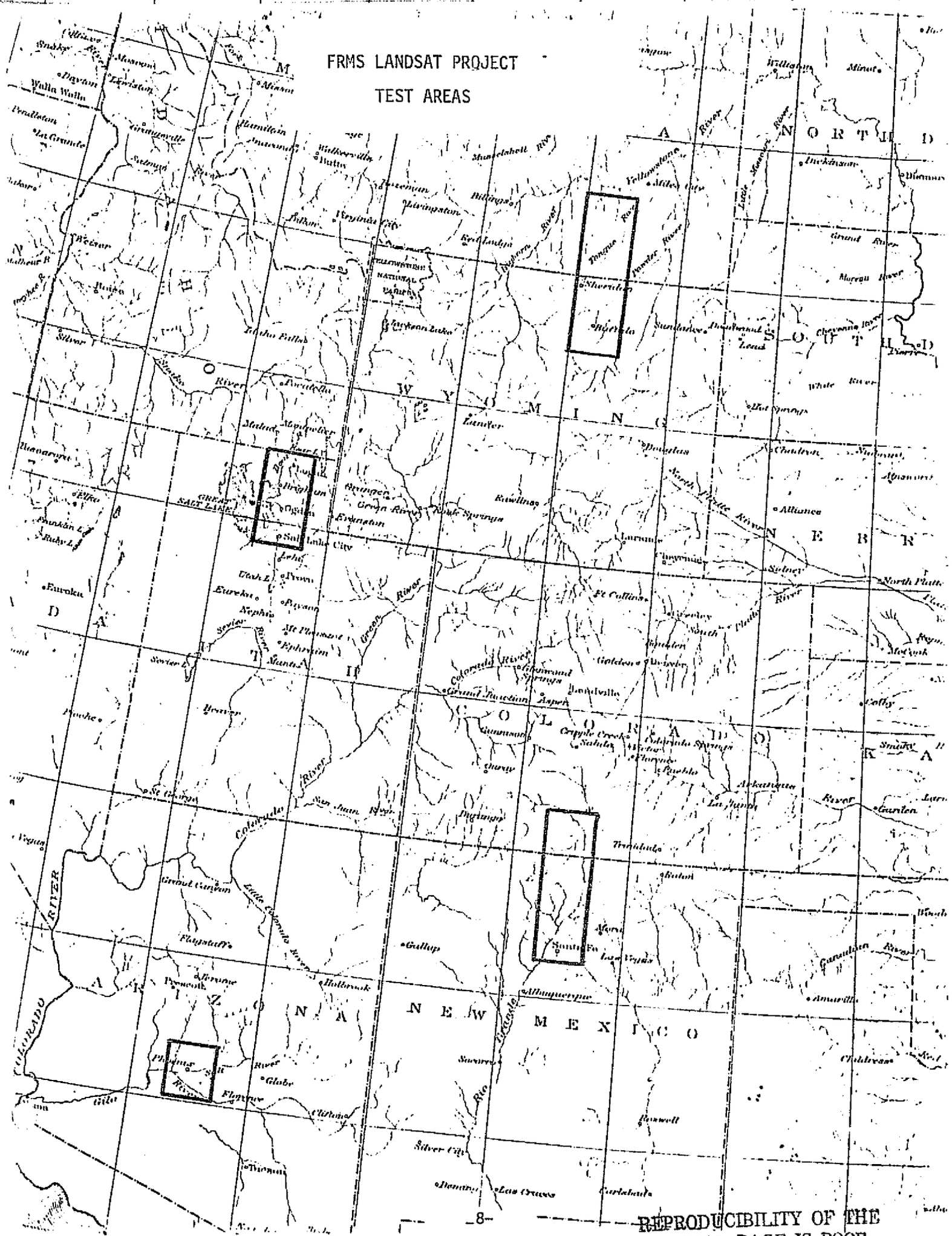


Figure 2

LANDSAT PROJECT

GENERAL LAND USE CATEGORIES

Residential	Marshlands
Industrial - Commercial	Brushlands
Deciduous Forest	Snow fields
Evergreen Forest	Bare lands
Mixed Forest (with decision rule)	Salt flats
Grassland - irrigated	Bare soil
Grassland - non-irrigated	Bare rock
Cropland - irrigated	Sand areas
Cropland - non-irrigated	Unclassified
Water - lakes, reservoirs, streams	
Water - shallow surface water	

Since the project uses cellular automated mapping techniques, it must provide for a wider range of data, reaching into the socio-economic, and permitting inter-topic composite analyses, as indicated in other work underway in the States and Federation[1/].

The project will supply land use overlay maps for all selected land use categories at the several chosen cell sizes, and these analyses will be designed to fit over standard 7 1/2 minute USGS map bases at the scale of 1:24,000.

The project is intended to establish an operating system in each state, through the hands-on participation by state technicians.

The final evaluation will include a comparative evaluation of the technical efficiency and cost of this system relative to other possible procedures for wide area resource surveys.

In respect to the various federal land management activities going on in this region the project will utilize federal resource data and classifications of resources and land uses, and will invite the participation of federal agency technicians. It is hoped that this will be particularly useful to the Department of Interior Resource and Land Information Program (RALI), and the programs of Soil Conservation, BLM and Forest Service. Among those programs there is much latent interest in a standardized ERTS and multi-source mapping system, for example: in the type of regional corridor studies such as the USGS Front Range Corridor Study, and the Utah Wasatch Front Geologic Study.

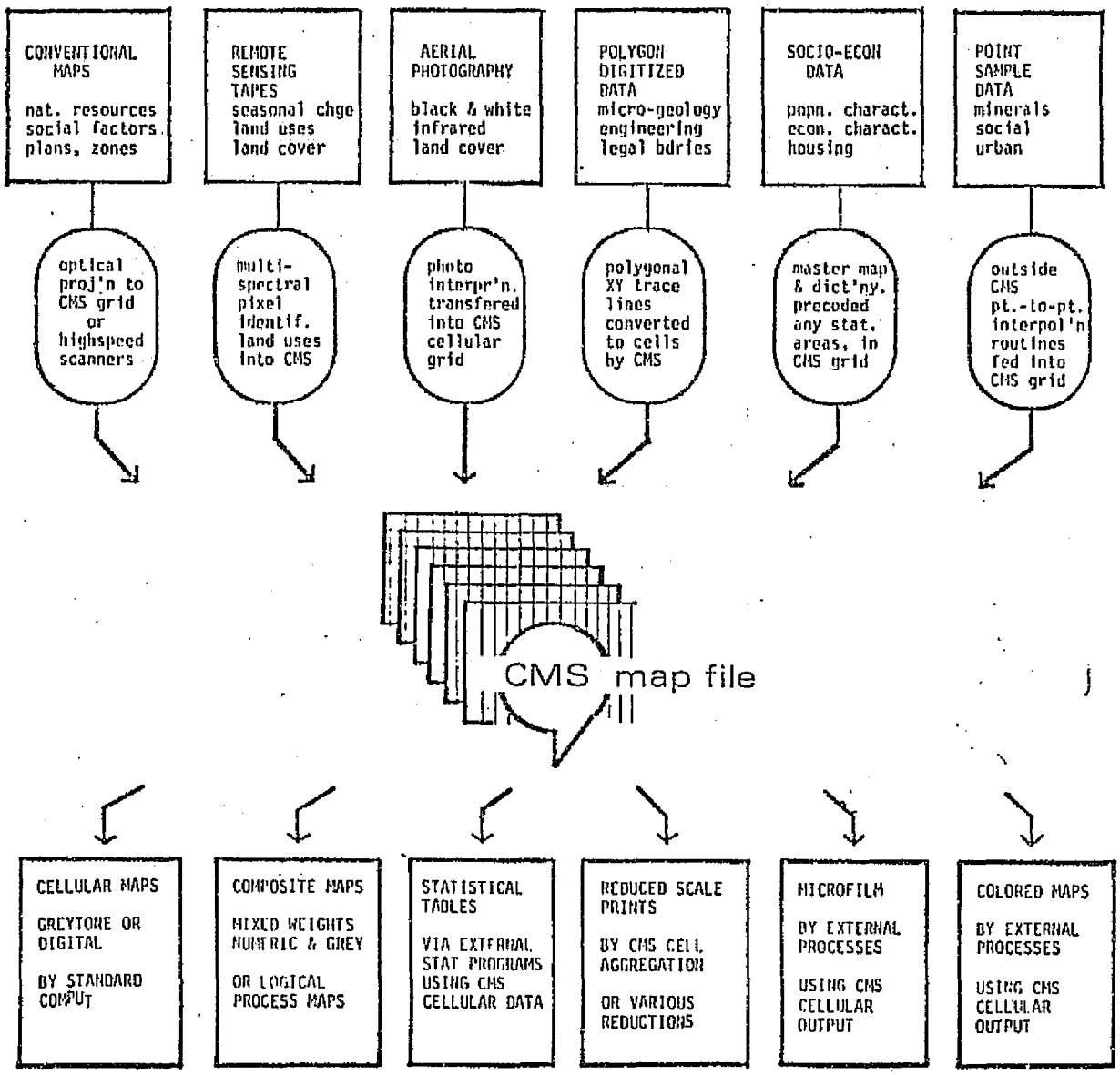
1/ Ibid. page 3.

SOME EXAMPLES

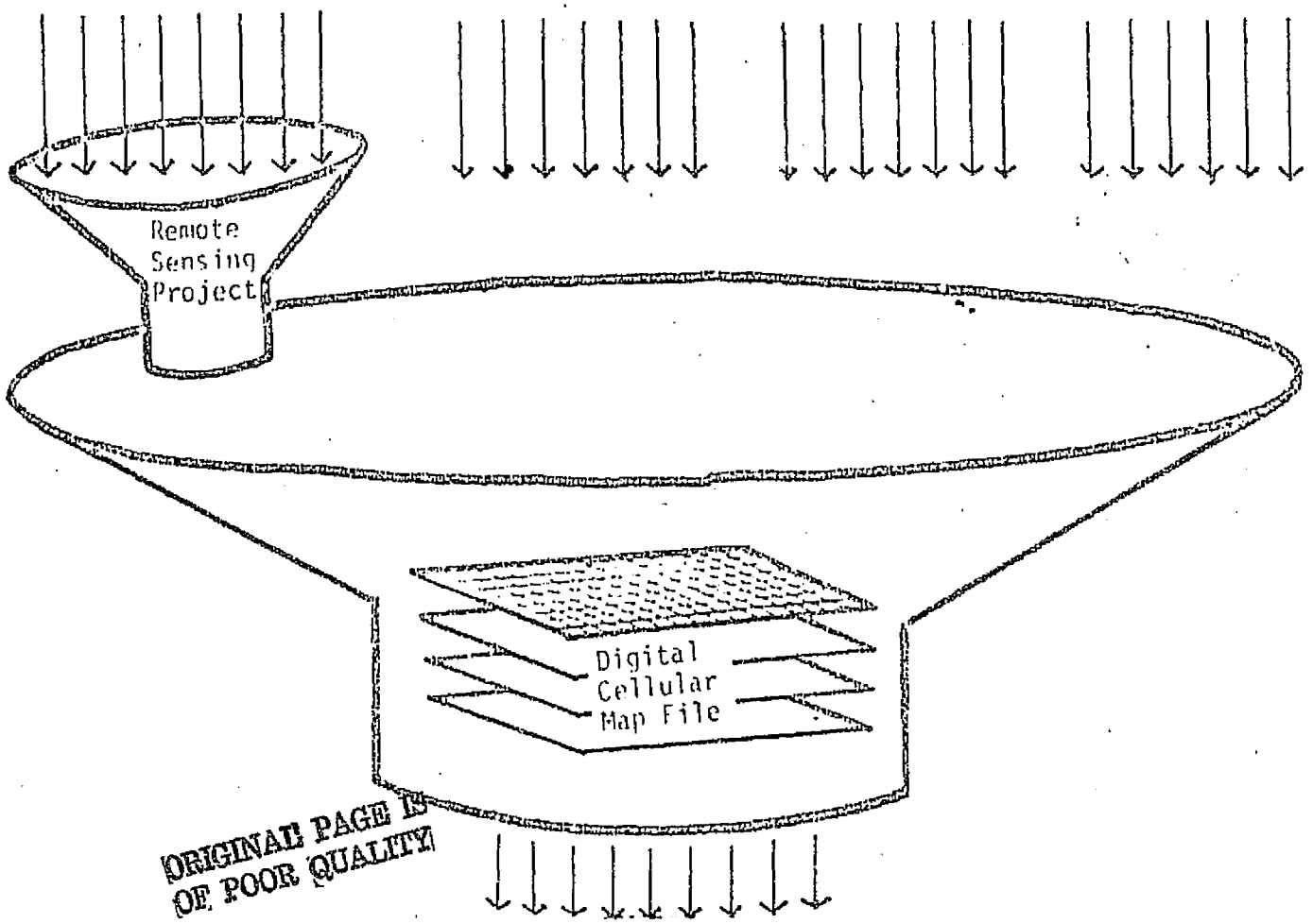
OF

COMPUTER COMPOSITING EFFORTS

Fig. 1.2.A VERSATILE INPUTS AND OUTPUTS

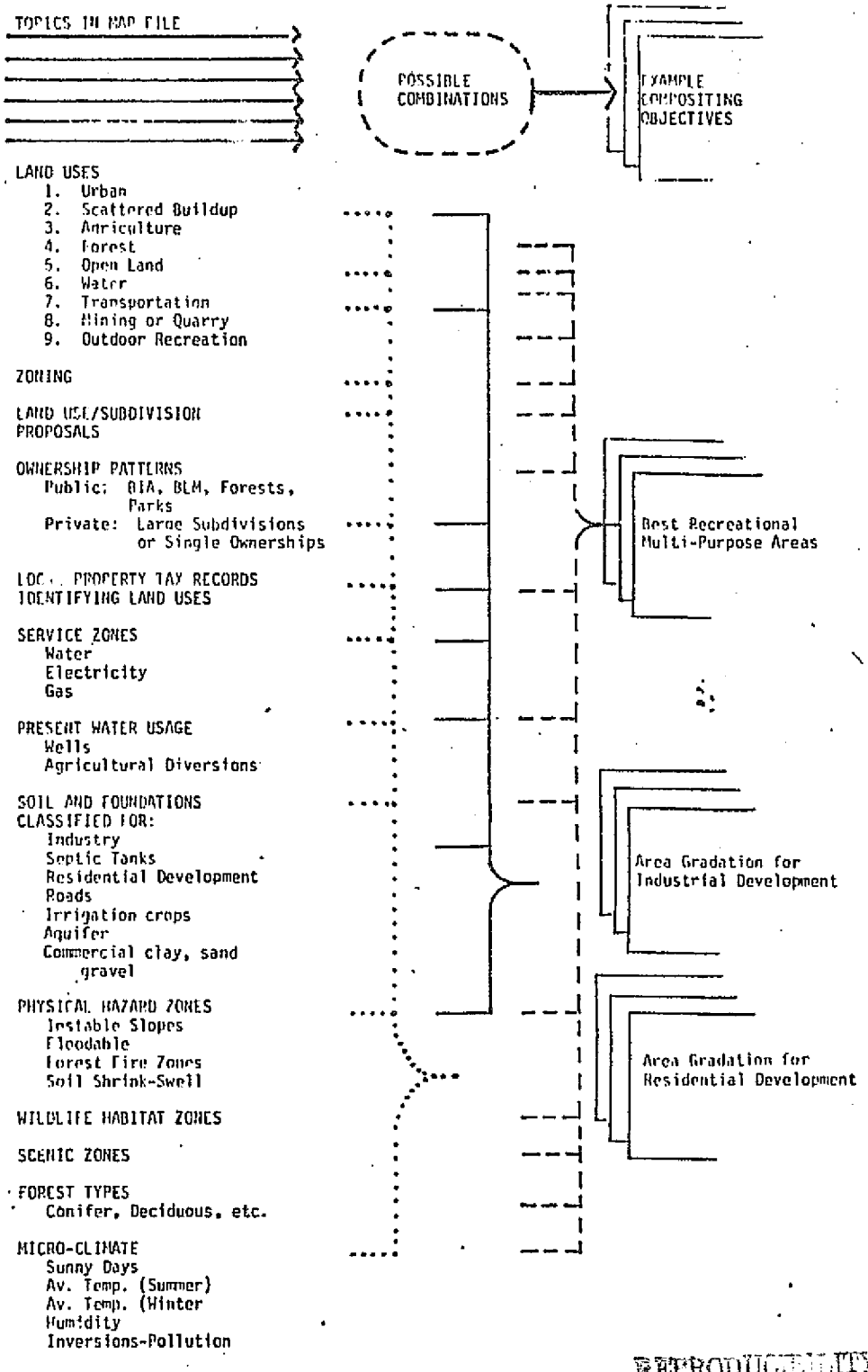


Landsat Demonstr. List	Other Basic Physical Surveys	Socio-Economic Area Data	Local Spot Information
Residential	Soils, Capability	Population	Area Zoning
Comm-Indust.	Precipitation	Growth	Subdiv. Filings
Forest Types	Groundwater	Composition	Dist. Boundaries
Grassland Types	Crop Production	Employment	Service Zones of Utilities
Cropland Types	Grazing Levels	Occupation	Service Zones of Schools, Hospitals, Etc.
Marshland	Forest Surveys	Income	Highway Corridor Capacities, Log
Two Water Areas	Geological, Mineral	Vital Stats.	Planned Areas for
Brushland	Level of Mining Activity	School Stats.	All Above
Snow Fields	Fish & Game	Recreation Stats.	
Bare Lands	Land Assessments	Sales Stats.	
Etc.	Etc.	Etc.	



USING A MAP FILE FOR VARIOUS COMPOSITING OBJECTIVES

When a cellular map file grows to a number of topics on resources and socio-economic factors, it readily lends itself to various compositing objectives. Typical objectives are shown to the right of the map file, which may be composited with arbitrary weights. This quick referencing is useful in environmental impact studies, growth area simulation for utilities, transportation, recreation, etc.

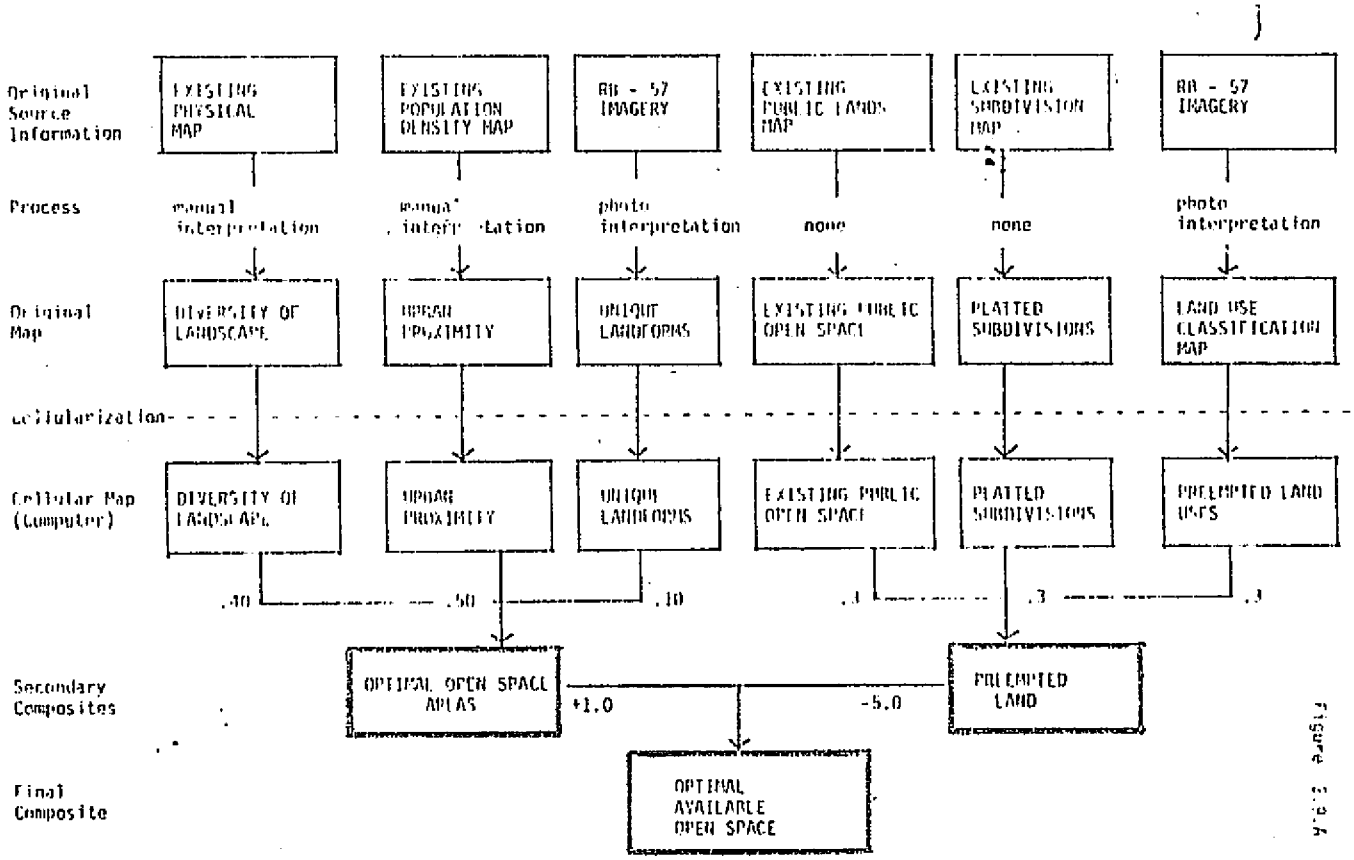


SELECTING PARK LAND IN A COUNTY BY SEVERAL COMPOSITE MAPPING STEPS

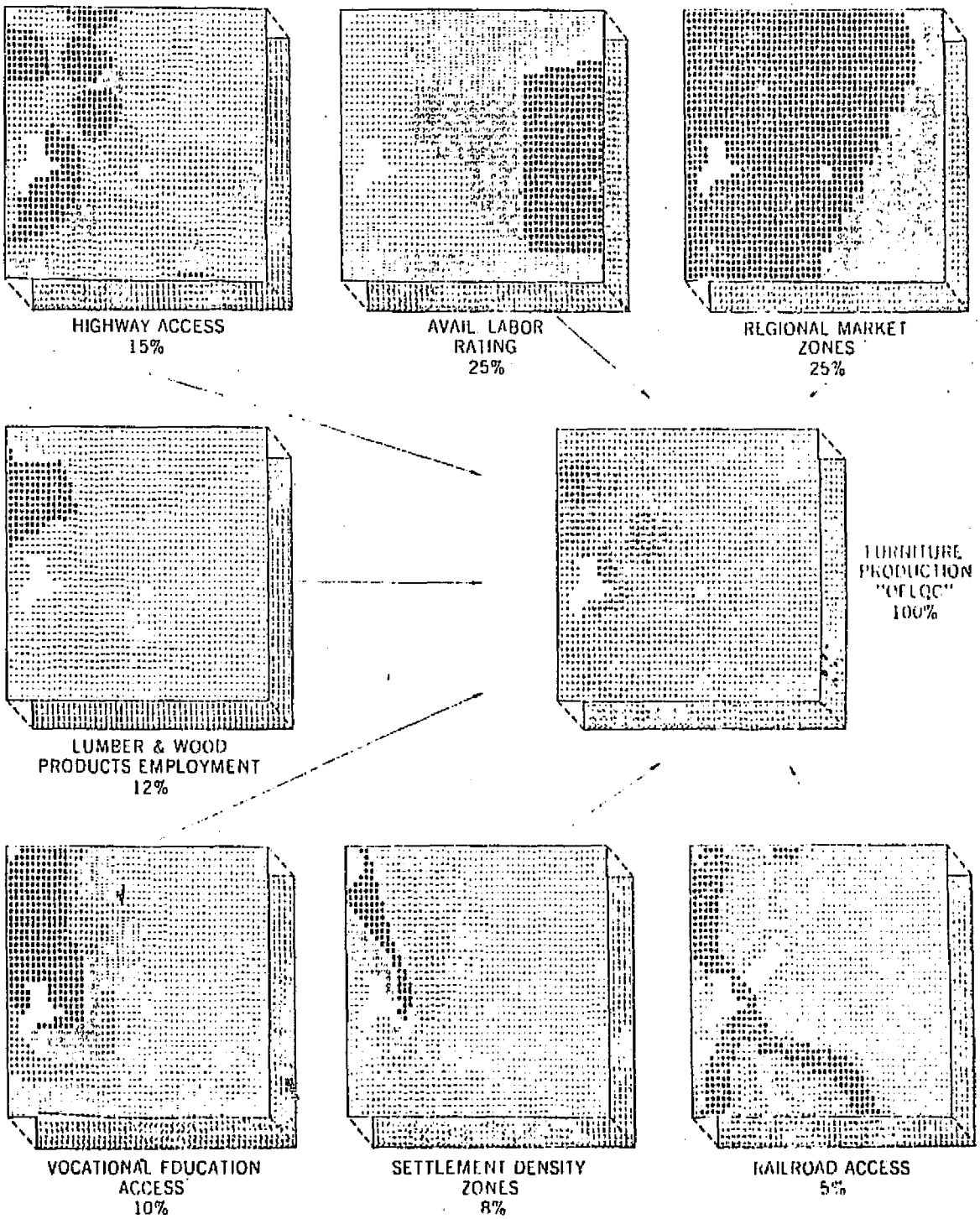
In a typical suburban county, extending from highly urban to sparsely settled rural and mountain areas, the problem was to locate numerous park and recreation sites, for advance public acquisition. Candidate sites had a number of constraints: natural ecology, relation to existing and potential housing, transportation accessibility, dual purpose land use with flood zoning, etc.

All the essential maps were collected rapidly, including high-altitude infrared photography of current land uses and vegetation. Standard geological maps showed topography, soil, and floodable conditions. Special interpretation overlays were drawn for significant land forms and scenic terrain, transportation corridors existing and proposed, population density and proximity.

All these maps and overlays were converted into cellular maps of 10-acre cell scale. Certain sets were then composited with relative weights. This resulted in a first cut of choice areas. These additional criteria were introduced in successive composites, to sharpen the site selection until cost factors could be applied.



SEVEN-FACTOR COMPOSITE MAPPING OF OPTIMUM LOCATION (OPLOC) FURNITURE PRODUCTION



These examples show only a small portion of Utah, so that digital detail can be seen in this reduction. The necessary area of search must cover a larger field, i.e. state or interstate region.

1.0

INTRODUCTION

SCOPE OF CMS-II

TABLE OF CONTENTS

Chapter 1.0

1.1 SCOPE

CMS-II designates a new version of the original CMS composite mapping program, now adapted to an IBM-OS environment. However, with typical changes in the machine environment division to fit hardware makes and models, the program will also run on UNIVAC 1108, Control Data 6000 or 7000, P.D.P. 10 and other equipment which can use ANS-COBOL. Memory core requirements for the IBM are 150K bytes (decimal), and for CDC 100K (octal) 10-character words (with segmentation). Other characteristics are given in this text and in the companion text CMS-II System Document ion.

The system is particularly suited to regional, state, and metropolitan land use and socio-economic planning. It is efficient in agricultural, hydrologic, mineral, and ecological analysis, or wherever necessary to collate many forms of maps, taped data, and tabular data. Practically any areal information, physical or socio-economic, can be fed into the system directly or through an intermediate step.

CMS-II is efficient for extensive area coverage, data banking, central information map files, at regional, state, or federal levels, or for extensive private or utility enterprises. It is also helpful for site specific analyses where its grid size can be set as fine as necessary. The efficiency grows with the scope of source materials, as CMS-II is designed to handle a comprehensive mapping bank.

Many research and planning operations in public and private sectors could interchange much more information if it were in a form to be interchanged--that is, in compatible scale and surface value classification. For example, a regional study of the pattern of land uses would require compatible information containing:

a. water conditions--snow pack, stream flow, reservoir levels, etc.;
b. forest conditions--timber and grazing levels, snow and watershed data, etc.;
c. agriculture--pattern of crops types, seasonal biomass, fertilization, water utilization, grazing loads, etc.;
d. minerals--active mining, surface and subsurface, status of leasing, etc.;
e. seasonal recreation levels--game and fish levels, seasonal sportsman populations, seasonal tourist loads, etc.;

f. urban change indicators--local indicators such as planned subdivisions, housing (new and conversion), recent changes of land uses, urban area expansion, infilling, change of density, etc.;
g. population--permanent and temporary residence, permanent and seasonal employment, ethnic and income characteristics, etc.;
h. transportation--origin and destination zone pattern and data, traffic volumes and modes in corridors, etc.;
i. land ownership--by major public and private categories, land valuation patterns, etc.;
j. environment--critical and sensitive areas, air pollution patterns, floodable areas, other natural hazard zones, micro-climatic maps, etc.

1.2 CELLULAR MAPPING VERSATILITY

This range of information must be sought from many sources in many forms. If it were available in uniform cellular form, it could be readily analyzed by logical, mathematical, or statistical methods. CMS-II is designed for lowest cost cellular conversion and for inter-map manipulations to carry out these analyses.

In setting up a regional cellular mapping system, the user must choose an appropriate grid cell size. He may wish to (1) preserve most of the detail from the original sources, and/or (2) match a standard base map of a certain scale, and/or (3) select an optimal scale for economy of handling a great variety of data and supplying many printed cell maps. These purposes may not always coincide. What he needs is not necessarily the finest resolution, but the most useable resolution. For example, for metropolitan planning purposes, detailed lot-by-lot information is not useful when most other data arises from census tracts, zip code zones, etc. In this case, he may select a medium grid cell size to serve both purposes.

Another solution is to set up several grid cell scales or map files--one fine and the other coarse. The CMS-II program permits interfacing both grids through an automatic aggregation of the smaller cells to larger cells.

The user also has available in CMS-II convenient methods to convert any form of input data into the cellular form. Original information may be in the form of remote sensing telemetry, aerial photographs, conventional maps in colors or symbols or sample points, or networks, streams, power lines, roads, etc. CMS-II will accept them, sometimes through intermediate processing steps.

Figure 1.2.A

POSSIBLE INPUTS AND OUTPUTS

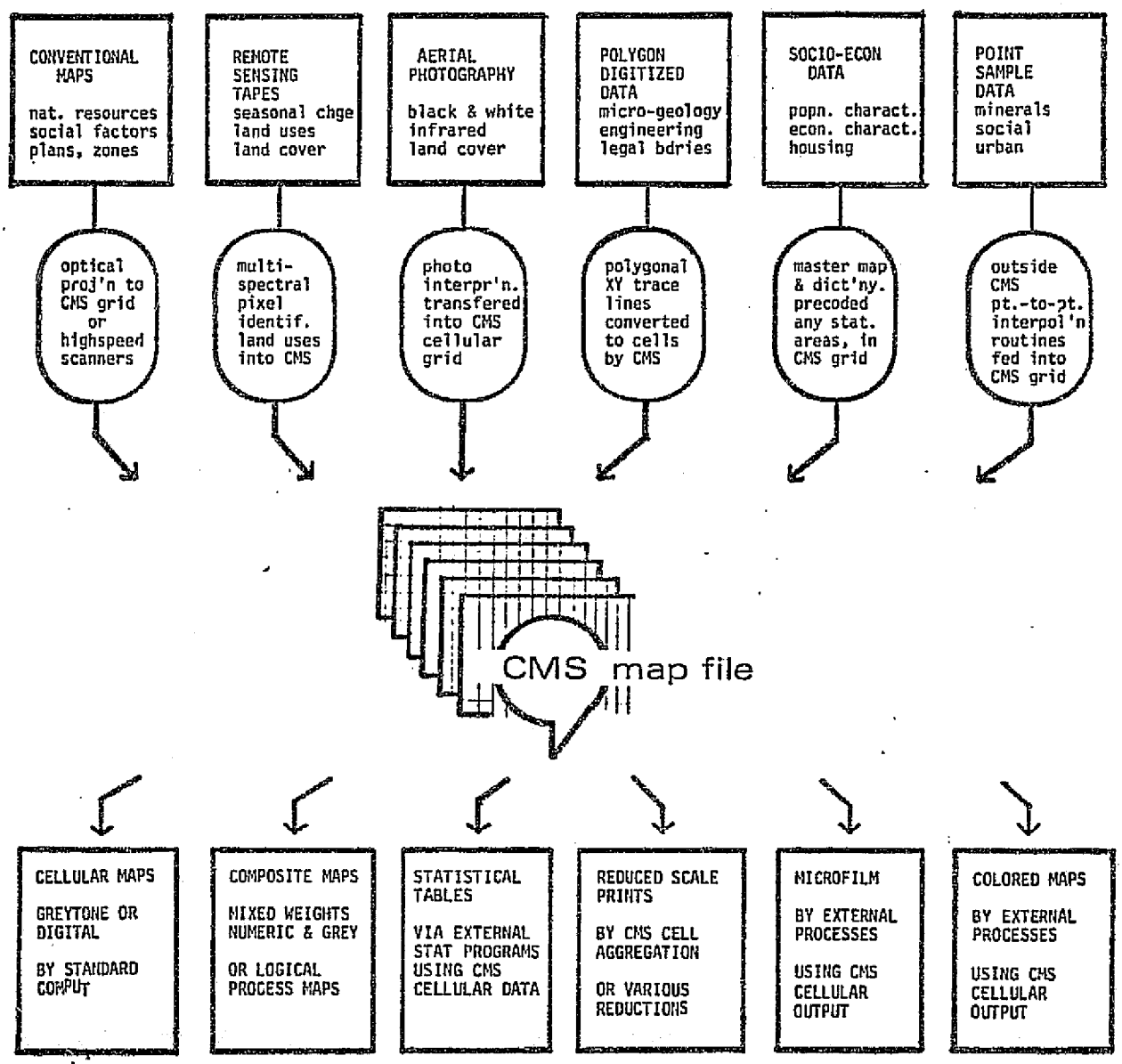
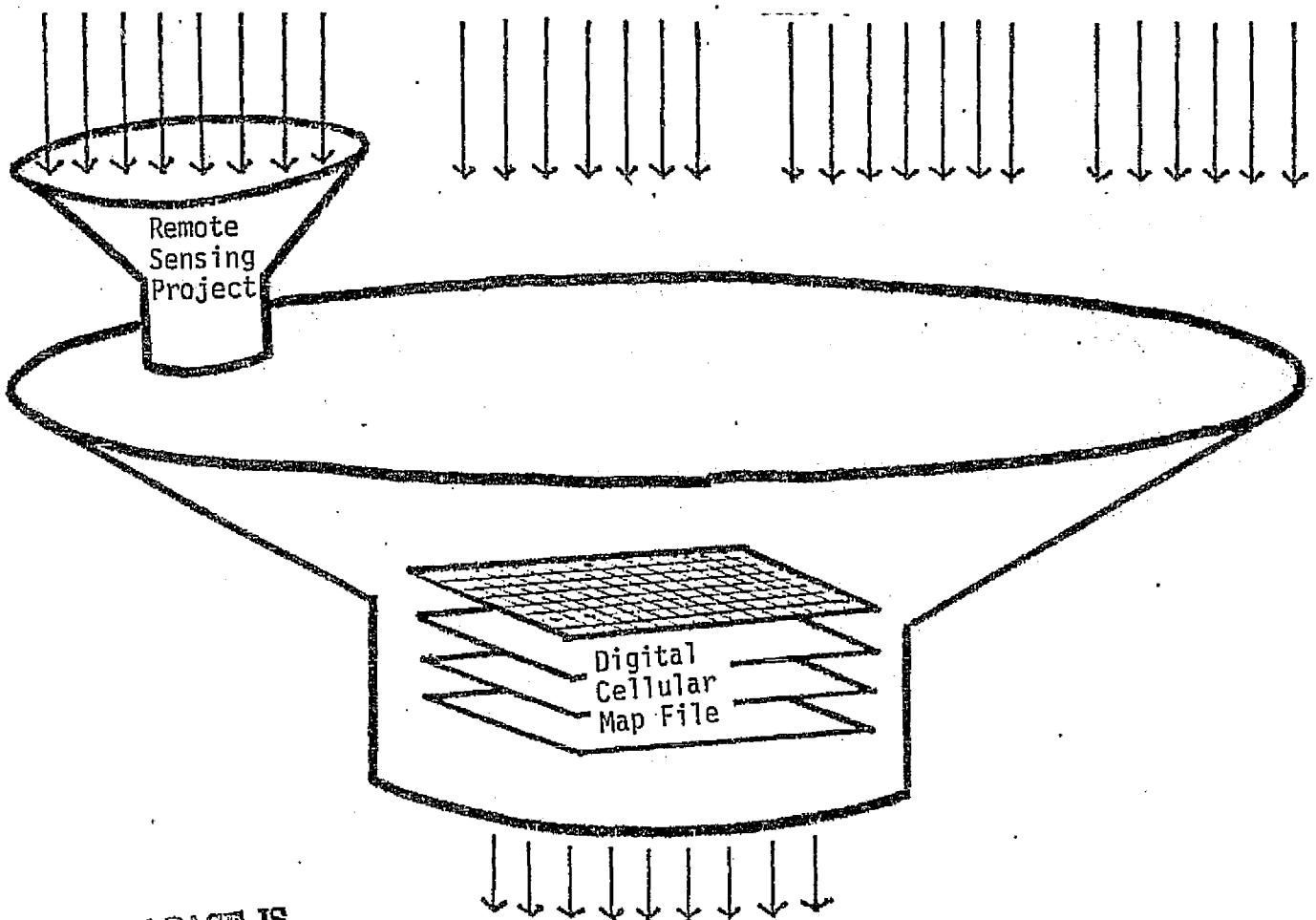


Figure 1.2.B

SCOPE OF REGIONAL INFORMATION SYSTEM

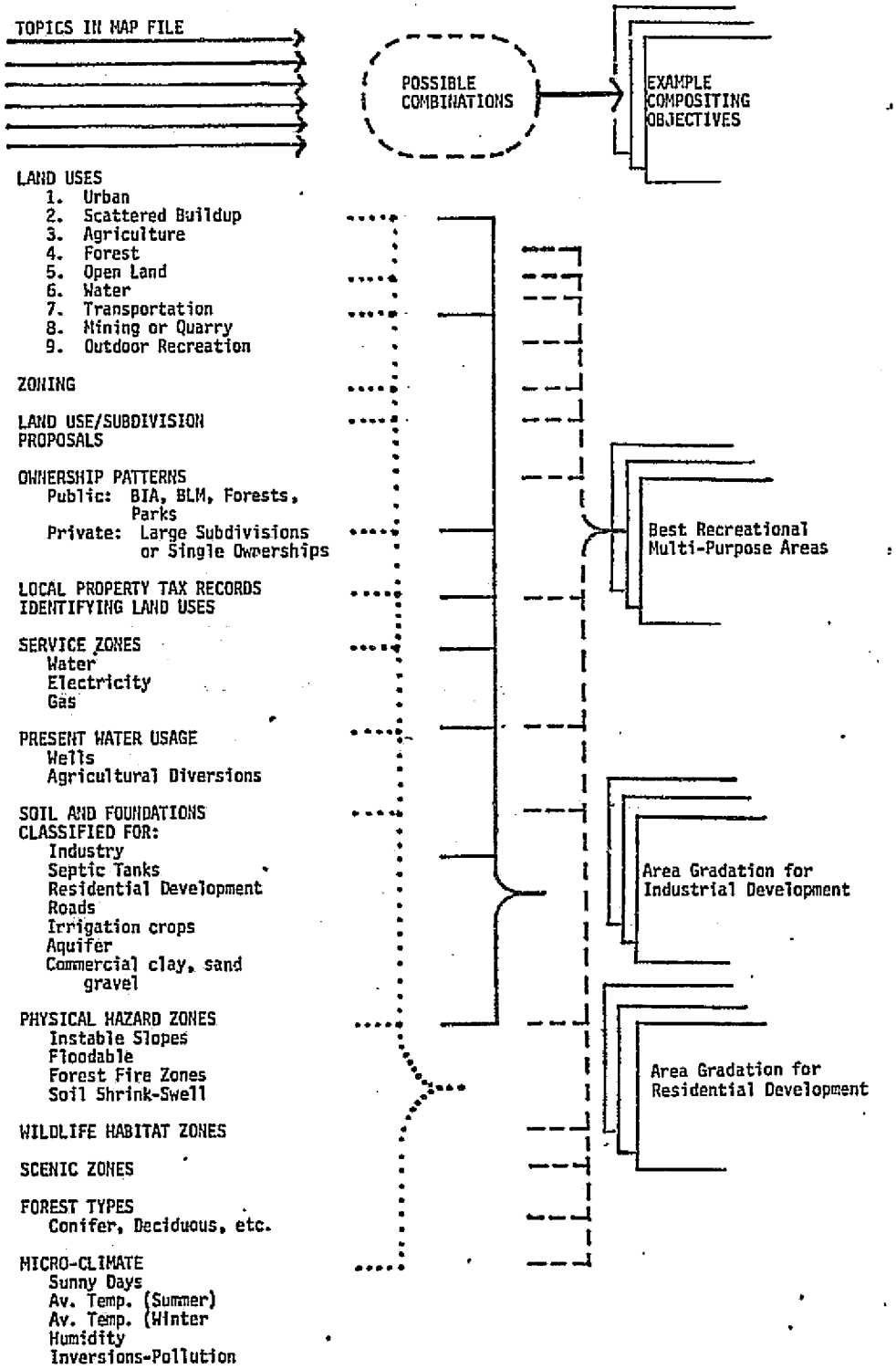
Landsat Satellite Mapping	Other Basic Area Data	Socio-Economic Area Data	Local Spot Information
Residential	Soils, Capability	Population	Area Zoning
Comm-Indust.	Precipitation	Growth	Subdiv. Filings
Forest Types	Groundwater	Composition	Dist Boundaries
Grassland Types	Crop Production	Employment	Service Zones of Utilities
Cropland Types	Grazing Levels	Occupation	Service Zones of Schools, Hospitals, Etc.
Marshland	Forest Surveys	Income	Highway Corridors, Capacities, Loads
Two Water Areas	Geological, Mineral	Vital Stats.	Planned Areas for All Above
Brushland	Levels of Mining Activity	School Stats.	
Snow Fields	Fish & Game	Recreation Stats.	
Bare Lands	Land Assessments	Sales Stats.	
Etc.	Etc.	Etc.	



1.3 USING A MAP FILE FOR VARIOUS COMPOSITING OBJECTIVES

When a cellular map file grows to a number of topics on resources and socio-economic factors, it readily lends itself to various compositing objectives. Typical objectives are shown to the right of the map file, which may be composited with logical weights. This quick referencing is useful in environmental impact studies, growth area simulation for utilities, transportation, recreation, etc.

Figure 1.3.A



1.4 COMPARISON WITH MANUAL COMPOSITING PROCEDURES

Some technicians in geology, urban planning, or environmental analysis have familiar manual overlay procedures for handling certain kinds of maps. These procedures gave the impetus for computer compositing procedures, which eased the following problems:

a. The number of maps which could be superimposed simultaneously by manual methods with any quantitative control was very small.
b. It was almost impossible to apply differential weighting to various maps, i.e., controlled compositing.
c. It was equally difficult to apply any basic statistical programs to conduct any multi-variate analysis, etc.
d. The manual-visual procedures were so slow that most available areal data was underutilized.

These problems are now generally resolved. Most original forms of areal information may be fed into the CMS-II system at far less cost than conventional methods of cross-analyzing maps or location data, but many new analytical advantages follow.

Manual-visual overlay procedures tried to combine maps to simulate real world relationships. They had been sliced into various layers and abstractions by the limitations of the visual media. These media were generally limited to colors and symbols for separately defined characteristics taken out of the context of interacting geographic, social, and economic factors. Now, computer compositing of cellular maps can go far toward reassembling these characteristics into controlled combinations, to test or to simulate relationships.

1.5 CMS-II COST BASIS - SOME AVERAGES OF MAN AND MACHINE TIMES

CMS-II is very economical by comparison with methods of manual or polygonal digitizing. For a test project of encoding and compositing Soils, Slope and Geology maps (Case 2.7), Colorado State University found the CMS-II cost to be approximately one-tenth of the cost of polygonal machine mapping, and incomparable with manual mapping because manual methods could not provide quantitative control in analytic compositing of several maps.1/

For rough estimating purposes, some approximate costs for common CMS-II steps are offered in the following tables. These are necessarily very general, as there will be great differences in the required coverage, precision, and analytic applications of a CMS-II mapping bank.

Figure 1.5.A

AVERAGE TIMES AND COSTS FOR CMS-II PROCESSING

MAN TIME - Typical Steps	Man Hours (Approx.)
a. Setting up the grid base, one standard sector at chosen cell size. Fitting it to the cartographic base. (See Chapter 4.) This step is needed only once and will be amortized over all succeeding uses of the grid).	8
b. Map encoding to grid from conventional maps or aerial photography and encoding to the grid (per sector).	2
c. Keypunching the grid, essentially punching only the changes and repeater symbols (per sector).	1
d. Feeding punch cards into the computer, obtaining test maps, making final card corrections.	1

1/ College of Forestry and Natural Resources, Colorado Environmental Data Systems, Part 5, Comparison of Analysis Systems; Colorado State University, Fort Collins, CO, 1972.

Figure 1.5.B

COMPUTER COST - An Example

Analytic Operations -

(1)	Read and store dictionary.	
(2)	Read and store master map.	
(3)	Display basic area master map (area symbols)	
(4)	Display aggregate area master map (selected summarized symbols) with Z-card symbol conversion.	
(5)	Four sets of P-cards (one sector each) -	
(6)	Perform two logic problems using above P-cards and display maps. .	
(7)	Read and store title, scale, and legend.	
(8)	Read and store additional topic maps, sets of P-cards (one sector each) and print out displays	
(9)	Perform arithmetic compositing of three sector maps.	
(10)	Retrieve dictionary and master map from old map file and print out display.	
	TOTAL COSTS (at a computer center having average rates).	$33.00

Regional Technical Advisory

Date: February, 1976

Federation of Rocky Mountain States, Inc.
2480 W. 26th Ave., Suite 300-B, Denver, Colorado 80211

Regional Technical Advisory is a brief description of a new technology or an important product, process, or method innovation that may have practical benefits for member state governments, educational institutions or private businesses. It is a service of the councils and staff of the Federation of Rocky Mountain States.

COMPOSITE MAPPING SYSTEM - II

This Technical Advisory announces the availability of the Composite Mapping System-II (CMS-II). CMS-II is a cellular computer mapping program for compiling and analyzing natural resources and socio-economic data by public and private planners. Applications of CMS-II include the production of maps showing: the degree of environmental limitations to development, optimal locations for various industries, areas of greatest need for social services, areas of land use conflicts, statistical explanations of geographic-related activities (i.e., power plant sites), and so on.

Inside:

Introduction

Much complex information and data are today required by physical and policy planners and managers. The situation promises to become more complex in the future as we learn more about our physical and social world. Planners must consider the social, economic and environmental causes and effects of most of the decisions they make. Not only data and information about these subjects are needed, but also analyses and projections.

These types of information and processes are especially relevant for decisions regarding growth management policy, land use planning, natural resources management and planning, and environmental quality monitoring (all require the use of geographic based information). Certain land planning problems (for example: the identification of areas for locating key facilities or for identifying critical areas, or for monitoring change) relate to geographic locations within given boundaries. The impacts of a policy decision regarding any of these activities can be measured or identified on a geographic level.

To further complicate matters, data collection, analyses, and decision-making are occurring concurrently at local, regional, state and federal levels. A central coordination, data clearing house and analytic mechanism is required. Such a mechanism and system must be user-oriented, current and cost efficient.

Tools are available to planners for handling large amounts of geographically related data. One such tool, a cellular computer mapping system (CMS-II), is described in this technical advisory and is now being made available to government and private sector decision-makers. A computerized geographic information system is a tool that can be used by decision-makers to solve many of the problems just discussed and to graphically illustrate the implications of various policy decisions. CMS-II could be an integral part of a comprehensive geographic information system.

To be useful to a decision-maker, an information system must provide a data library and retrieval function, but more importantly must provide the user with a variety of options for analyzing data and determining the effects of various decisions, whether they be objective or subjective. The CMS-II system provides for efficient low-cost retrieval of data, easy access for updating data, and it has the analytical capabilities for compositing (stacking several maps on one another) many maps and conducting other analyses.

The CMS-II system can use variable cell sizes and map scales to fit the available data or the scope of planning. For example, a planner may wish to conduct site specific analyses, county analyses, multi-county analyses, or state analyses with a variety of data which may come from various sources, including: census tapes, point/polygon digitized tapes, remote sensing computer tapes, conventional maps and aerial photos, proposed plans and activities, and tabular data. CMS-II also offers the user a choice of outputs: greytone and alpha-numeric maps, tables and histograms, and others, depending upon available hardware.

Background

CMS-II is a cellular mapping computer program capable of storing and mapping spatial patterns of economic, social, and physical resource factors within any selected study area and at any map scale. Among its special features is the capability to merge related sets of maps into weighted combinations or composite maps. CMS-II is sophisticated and flexible, allowing investigators from many fields--public and private--to quickly evaluate the areal distribution and inter-relationships of available factors.

The composite mapping concept was developed by George Nez and others at Kansas State University in the mid-1960's. He brought this concept to the U. S. Economic Development Administration (EDA), where a map analysis program (MAP) was developed for use in multi-state regional planning. MAP was redesigned into the more comprehensive and flexible composite mapping system (CMS). Since that time, a continuously developing CMS has produced more than 240 maps, many of which have been multi-factor composites at a variety of scales, covering a wide range of subject matter. CMS was originally programmed for use on UNIVAC and CDC computers.

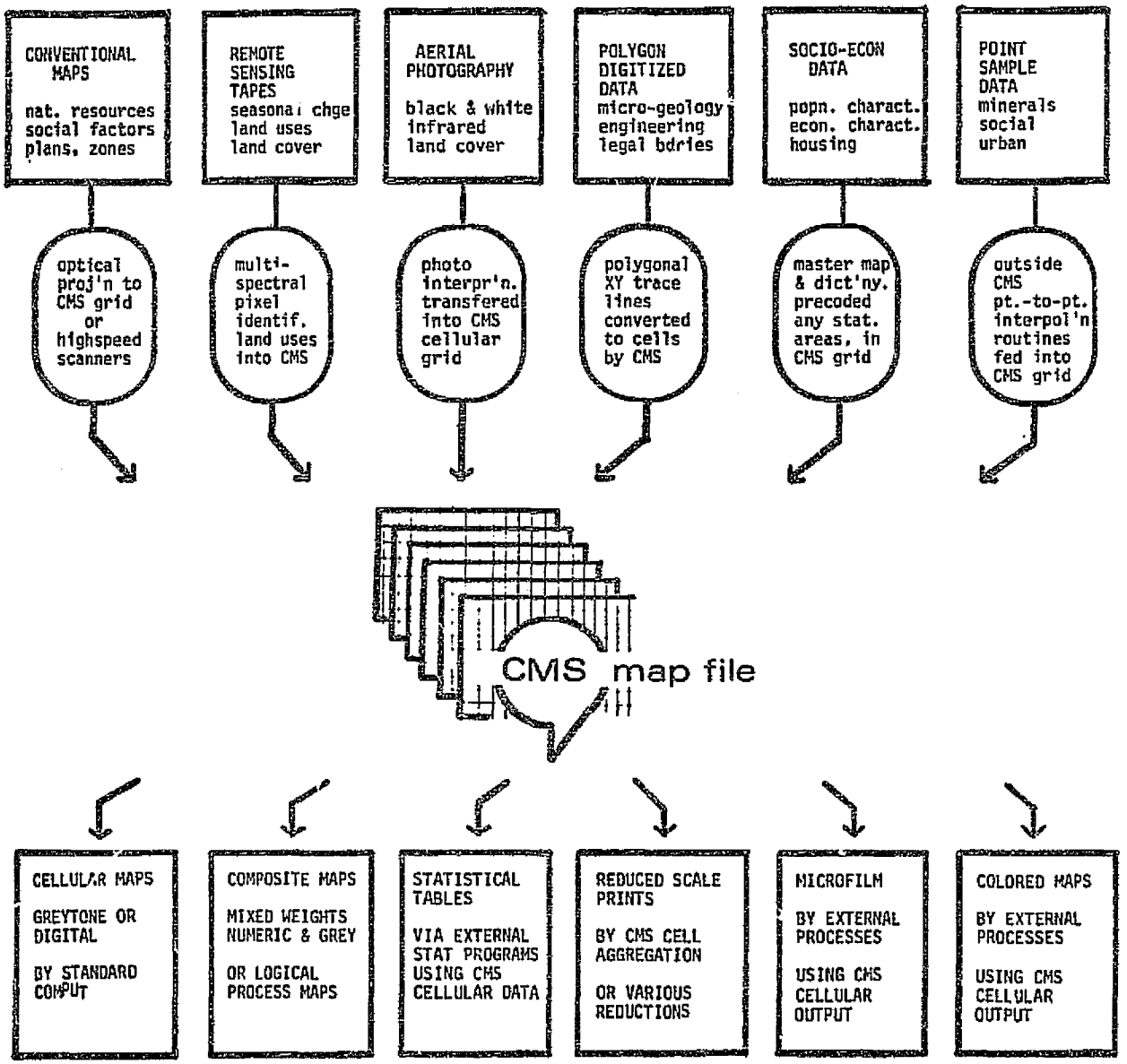
In 1974, EDA provided a grant to the Federation of Rocky Mountain States (FRMS) to undertake a substantial redevelopment of CMS for use on IBM computers with ANS-COBOL compilers. CMS-II is the result of that effort. The refinement of CMS involved the Federation and subcontractors, the Economic Development Administration, the Public Service Company of Colorado, the University of Idaho, the State of Idaho, and the U. S. Bureau of Reclamation.

Applications

Users of this computer analysis system include social, economic, and physical resource researchers and planners, as well as others interested in the geographic analysis of variables. The system is particularly suited to regional, state, and metropolitan land use, environmental, and socio-economic planning. It is efficient for use wherever it is necessary to collate and analyze many forms of maps, remote sensing data, computer tape information, and tabular data. Practically any areal information can be fed into the system, either directly or through intermediate steps. CMS-II is useful for extensive areal coverage, data banking, central information map filing, site-specific analyses, and analyses using many multi-source data forms.

CMS-II is a basic program for a comprehensive geographic information system. It is inexpensive, efficient, simple to operate, uses multi-source information (see the following figure), and provides flexibility in selecting a variety of analysis procedures and output forms.

Versatile Inputs and Outputs



Multi-map compositing and statistical analysis are key features. Maps and other forms of data from various sources can be combined with desired weights to produce new composite maps. The composite maps graphically indicate, for example, areas of conflict, areas of potential future activity, areas of need, or optimal areas, and so on. Following are some specific examples:

1. An index map of socio-economic deficiencies in a metropolitan area was produced by combining separate maps of income levels, educational attainment, housing conditions, unemployment rates, health conditions, health care availability, and percentage of the population in minority groups. This information was obtained from several sources in various forms, tables, maps, and census tapes. The composite map was then compared with data on local welfare and development expenditures, to ascertain how well social programs match needs.

2. In a state-wide health needs study, twenty-nine selected vital statistic maps were weighted and composited to identify areas having different degrees of need for (a) long-term hospitals and nursing homes, (b) short-term hospitals, (c) maternity services, (d) pediatric services, (e) pharmacy services. The input factors included a great variety of topics such as population 65 years and over, deaths per thousand population from cancer, ethnic patterns, physicians per one thousand population, highway accessability, etc.

3. A wide multi-state search for optimal areas for locating certain industries selected 29 target industries, including mining machinery, handicrafts, apparel, office machines, wood furniture, for example. Many resource maps were input and weighted for compositing, including railroad service zones, public airport accessability zones, population distribution, croplands, medium-skill employment patterns, county work force, etc. Various combinations and weights were run to map out the most suitable locations for specific target industries.

4. A county-level application graphically identified hazardous areas for residential development. A variety of topic maps were cell-mapped, including: soil suitability for residential buildings, flood hazards, fault zones, areas of mass wasting, and septic drainage conditions, private land ownership, existing housing areas and planned residential areas (from the county plan). Composite maps were produced, showing hazardous areas in the county and how they related to existing and proposed development.

5. A current demonstration project stretches from Montana to Arizona, using 24 areas of 55 square miles each, to map out land use and vegetation from the LANDSAT satellite, and to superimpose standard surveys, aerial photographs, conventional resource maps, digitized point/polygon data, and socio-economic data. The CMS process will inter-relate these factors for model solutions to given management problems in each area.

Design Concepts

CMS-II is written in ANS-COBOL in six modules, CMS01 through CMS06. These routines are designed to operate most efficiently on IBM 360/OS or IBM 370/OS environments. They are, however, relatively machine independent and can be easily modified to operate on the CDC 6000, PDP 10, or UNIVAC 1100 series computers. Core requirements of the largest routines are 150K bytes (decimal) for IBM machines and 100K bytes (octal) for CDC machines with COBOL segmentation. A technical description of all programs is provided in the CMS-II Systems Documentation.

CMS-II is capable of storing and manipulating cell values through various mathematical, statistical, and logical subroutines. CMS-II is compatible for use with LANDSAT computer tapes, digitized polygonal tapes, conventional maps and remote sensing data, tabular data, census tapes, standard statistical routines, and other information system programs. Some of the features of CMS-II include: internal storage of maps (map filing); instant symbol conversion; inter-map arithmetic compositing through addition, subtraction, multiplication, or division from point-to-point or map-to-map; inter-map logical compositing, frequency distribution or histogram outputs; aggregation of cells; various alpha-numeric grey tone or other outputs--depending upon hardware; the use of master maps and dictionaries for assigning tabular data to fixed areas (counties, for example); and the ability to feed map files into multi-variate statistical programs. Input data can be digitized or manually coded. The system is set up for easy manual coding, so that expensive hardware is unnecessary.

Availability

The CMS-II program package is available to anyone and may be obtained from the Federation of Rocky Mountain States. This is a program originating with the U. S. Economic Development Administration; and, therefore, any requestor must obtain a release agreement from EDA. To obtain a release agreement, send a request letter, similar to that shown in Appendix A. Upon receipt of the agreement form, it should be signed and returned to EDA with a copy sent to the Federation.

The attached Federation order form (Appendix B) should be used only after a requestor has signed and returned the release agreement to EDA. A copy of that agreement, plus payment or purchase order, should be attached to the order form and sent to the Federation.

Cost of the complete program package is $250, which covers printing and duplication costs, computer tape and tape copying, storage, and handling and administrative costs. This base price also includes telephone/mail consultation on system installation with the chief technical programmer of CMS-II.

Users of the system will receive periodic updates as changes are made in any documents or in the program tape.

For More Information

For more information on CMS and EDA's applications, contact:

John B. Fieser
Program Planning Division
U. S. Economic Development
Administration
Main Commerce Building - Room 6100
Washington, D. C. 20230
(202) 967-2900

For more information on CMS-II, contact:

Douglas L. Mutter or
George Nez
Federation of Rocky Mountain States
2480 West 26th Avenue - Suite 300B
Denver, Colorado 80211
(303) 458-8000

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APPENDIX A

SAMPLE RELEASE REQUEST LETTER

Mr. John B. Fieser
Program Planning Division
U. S. Economic Development Administration
Main Commerce Building - Room 6100
Washington, D. C. 20230

Dear Mr. Fieser:

This is a request for a formal release agreement from you to obtain and use the Composite Mapping System-II (CMS-II) program now available from the Federation of Rocky Mountain States.

CMS-II will be used by _____(organization)_____
for _____(nature of proposed uses)_____
_____

Please send the release agreement to:

_____(name and title)_____

_____(organization)_____

_____(address)_____

I understand that I will then return the signed agreement to you and a copy to the Federation.

Thank you.

Sincerely,

_____
_____

APPENDIX B

CMS-II ORDER FORM

Return to: *Douglas L. Mutter*
CMS-II
Federation of Rocky Mountain States, Inc.
2480 West 26th Avenue - Suite 300B
Denver, Colorado 80211

Please send me the CMS-II program package. I have signed a release agreement with the U. S. Economic Development Administration and have attached a copy of that signed release.

I am enclosing payment or purchase order made to the Federation of Rocky Mountain States for the following:

One CMS-II program package at a cost of $250.00: $____.___
(This program package includes one copy each of the Systems Documentation, Users' Manual, and program tape.)

(No.)____and/or extra Users' Manuals @ $15.00 each for a total of: $____.___

TOTAL AMOUNT: $____.___

- - - - - - - -

The tape specifications I wish are: (please circle)

1. Density: 800 BPI 1600 BPI
2. Character codes: ASCI EBCDIC BCD
3. Track: 7 9
4. Standard tape label: Yes No
5. Machine: IBM CDC

Please send the package to: (please print)

Name: _____

Title: _____

Organization: _____

Address: _____
(Street)

_____
(City, State, Zip)

_____
(Phone)